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AIRBORNE PERFORMANCE MEASUREMENT SYSTEM DESIGN: C-5 AIRCRAFT

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This study identified and defined the required functional capabilities of an airborne performance measurement system for the C-5 aircraft. The requirements of the airborne PMS were defined to satisfy both research and training needs. A mission equivalent to the nominal mission utilized in the C-5 flight simulator PMS was defined. The C-5 aircraft signals that can be extracted to support the performance measurement of this mission were identified. From this a series of design approaches for an airborne PMS was developed. A system design specification was produced for an airborne PMS system selected from these design approaches.

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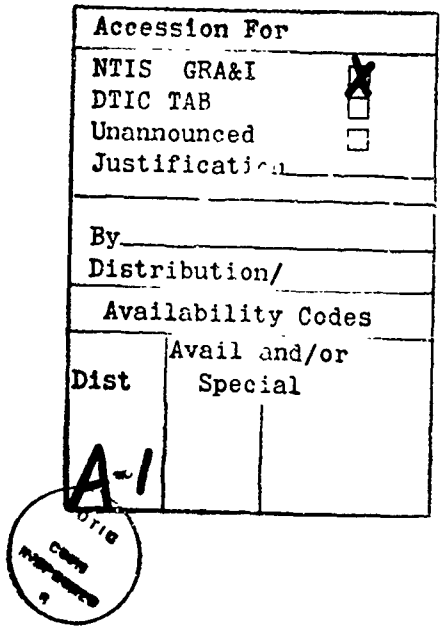

SUMMARY

The objectives were to define the requirements for an aircrew performance measurement system (PMS) for the C-5 aircraft and, based on these requirements, to develop a system design specification for an airborne PMS that would gather data from the aircraft and generate objective measures of aircrew performance.

Commencing in 1976, a research and development (R&D) effort defined the requirements for a PMS for C-5 aircrew members. The resulting PMS was installed on a C-5A flight simulator to provide the instructor with real-time and post-mission feedback of student performance, as well as to record proficiency assessment data for future analysis. Next, an airborne PMS capability was to be developed so that equivalent measures of crew performance could be generated in both the simulator and the aircraft. This R&D was conducted in three phases. Phase I identified and defined the required functional capabilities of an airborne PMS. Phase II analyzed the systems of the C-5 to identify available signal sources for use by the PMS and developed a series of design approaches for an airborne PMS. Phase III produced a system design specification for the selected airborne PMS system.

Interviews and discussions were conducted to determine training and R&D needs, and the results were used to define an airborne nominal mission. This mission was compared to an equivalent simulator PMS mission in order to define the airplane signal requirements; however, not enough signal information could be extracted from the C-5 to fully support an airborne PMS equivalent to a simulator PMS. Enough data could be obtained to provide equivalent measurement in approach and landing crew performance; therefore, an alternative design approach resulted in a detailed specification that conceptualized airborne PMS as composed of two systems interfaced to each other by a recording medium. The C-5 airborne recording system is composed of a microprocessor-based controller which extracts data from three airplane systems and records the data on magnetic tape. The ground-based processing system employs the simulator PMS hardware plus a magnetic tape unit and modified software. It will process recorded data from the airplane and produce outputs equivalent to the simulator PMS.

It is concluded that development of a fully equivalent simulator/airborne PMS for the C-5 is not feasible due to the requirement for a large number of signals and the need for extensive modifications to obtain these. It is recommended that PMS requirements be considered as an integral part of the initial aircraft design to avoid retrofit problems experienced in this C-5 PMS design attempt.

PREFACE

This research represents a portion of the program of the Air Force Human Resources Laboratory Technical Planning Objective, the thrust of which is air combat tactics training. The general objective of this thrust is to identify and demonstrate cost-effective training strategies and training equipment for use in developing and maintaining the combat effectiveness of Air Force aircrew members. The specific problem addressed by this effort was the lack of an objective means of assessing crew performance in the aircraft and the relation of such measures to performance in the simulator. The purpose of the study was to design a system whereby objective performance data could be collected in the C-5 aircraft. The effort is part of Project 2359, Pilot Performance Measurement Systems, and represents a follow-on to the development of a measurement system for the C-5 flight simulator. The work was accomplished by Logicon, Inc., San Diego, California, under contract F-33615-83-C-0025. Mr. Charles Schmitt was the Principal Investigator for Logicon, Inc. Dr. Wayne L. Waag was the contract monitor for the Air Force Human Resources Laboratory.

The conduct of this effort was made possible by the outstanding support of personnel from the Military Airlift Command. Major James Stephenson served as the principal point of contact at MAC Headquarters at Scott AFB, Illinois. Lt Col Ruud Hartog, 443 MAW/DOS was the principal point of contact from the training wing at Altus AFB, Oklahoma. SSgt Duane Brown served as the focal point for those aspects of the effort concerning the flight engineer crew position. Their assistance throughout all phases of the effort was considered invaluable. And finally, special thanks are extended to all squadron personnel at Altus AFB whose professional attitudes and expertise made this work possible.

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INTRODUCTION

Background

The advance of technology in the use of simulators for flight training has been substantial since the first design of simulators. Today, flight training simulators are highly complex devices capable of total aircrew training of almost all flight tasks. The increased procurement and operating costs of both aircraft and simulators have resulted in an awareness of the need to quantify the effectiveness of training techniques in order to achieve the most cost-effective overall training approach.

Performance measurement techniques are an essential component of aircrew training programs. Specifically, they must be used to measure objectively the progress of students through the training and to determine the effects of training program modification.

In late 1973, the Air Force Human Resources Laboratory (AFHRL) initiated a consulting dialogue with the Military Airlift Command (MAC). In an attempt to obtain further assistance, MAC initiated a Request for Personnel Research (RPR) in which one of the objectives concerned the application of training effectiveness measurement to the evaluation of their training programs. Although the initial RPR was not approved, these objectives were included in the Air Force Master Simulation Plan and the dialogue between AFHRL and MAC continued. In May 1976, MAC initiated another RPR (76-20), entitled "Aircrew Performance Measurement System," which was subsequently validated.

The objectives of this RPR were:

1. To identify objectively the mission task requirements for MAC aircrew members through an analysis of training syllabuses, STAN/EVAL performance criteria, and flying training records when appropriate.

2. To describe current and planned flight simulator and aircraft capabilities in terms of their use in generating mission performance measurement for MAC aircrew members.

3. To develop and evaluate an objective/quantitative measurement system for MAC aircrews based on the mission task requirements and the capabilities of command flight simulation systems as well as the aircraft.

A joint effort by AFHRL and MAC was initiated with the goal of developing a prototype system for the C-5 aircraft.

In July 1976, the Air Force awarded a three-phase research and development (R&D) contract entitled "Definition of Requirements for a Performance Measurement System for C-5 Aircrew Members." The general objective of the effort was to define requirements for a valid, reliable, objective/quantitative performance measurement system for members of the C-5 aircrew, utilizing the existing C-5 simulator. The R&D was subsequently extended to determine the feasibility of expanding the performance measurement beyond the simulator to include the C-5 aircraft. The complete results of the research effort were published as an AFHRL technical report (Swink et al., 1978).

Based on the functional requirements described by Swink et al. (1978), a contract was awarded in 1978 for the development, fabrication, and integration of a Performance Measurement System (PMS) for the C-5A flight simulator. The PMS developed is currently operational with a C-5A flight simulator located at Altus AFB. The simulator PMS provides for real-time aircrew performance measurement in the areas of checklist/procedure execution, navigational profile adherence, and parameter monitoring. In addition, the PMS provides for the automatic insertion of simulator malfunctions. The PMS provides the instructor with real-time and post-mission feedback of student performance. It also provides for the recording of proficiency assessment data for future retrieval and statistical analysis.

Study Objective and Tasks

The complete study of aircrew performance measurement must include both the simulator and the airplane environment. Of critical importance is the relationship of measured performance in the simulator to measured performance in the aircraft. Ideally, what is required is an intregrated simulator/airborne performance measurement system which enables the generation of equivalent indices of aircrew proficiency in both environments. The objectives of this effort were to define the requirements for an airborne measurement system and to develop a design specification based on the requirements.

The work was conducted in three phases having the following objectives:

1. Phase I - To identify and define the required functional capabilities of the airborne PMS.

2. Phase II - To analyze the availability of required airborne data signals and to define alternate approaches to provide an airborne recording capability and a ground-based processing system.

3. Phase III - To develop a specification for an airborne performance measurement system including the airborne recording system and the ground-based processing system.

SECTION II

PHASE I - REQUIREMENTS

The objective of Phase I was to analyze the requirements for performance measurement of C-5 crew members during the period of flight training. The training period considered was the flight training section of the copilot and flight engineer initial qualification courses. The goal of this phase was to define the set of required functional capabilities for an airborne performance measurement system which would support the objective evaluation of aircrew proficiency. An additional task of this phase was an analysis of the C-5 recording capabilities to determine sources of crew performance data. The data sources for this analysis consisted of operational and training documentation, interviews with instructors and evaluators, and discussions with research personnel.

Research and Development Needs

The Air Force Human Resources Laboratory (AFHRL) has sponsored C-5 PMS study and development efforts since the commencement of the program in 1976. While a side goal of the airborne PMS is to enhance C-5 crew training, the primary benefit is to obtain crew performance data for AFHRL use. The data collected will be used by AFHRL and other agencies to assess the effectiveness of airborne and simulator training and the transferability of training from the simulator to the aircraft. In addition, these data may be utilized to predict or test the effects of training program modifications.

The AFHRL data requirements fall into two categories: raw data and processed data. Raw data can be defined as data extracted and recorded exactly as it is generated by airplane systems. This same type of data has been targeted to be recorded by the simulator PMS. Two examples of raw data are parameters describing the state position of the aircraft (e.g., altitude, airspeed, position) and parameters that monitor control activity (e.g., yoke movement, throttle position). The recorded raw data could be used in a comparison of equivalent data from the simulator and the aircraft, such as a comparison of throttle movements on final approach.

Processed data are defined as performance data which have been extracted, processed according to predefined algorithms, and recorded as summary measures of aircrew performance. A primary goal of the C-5 performance measurement system is to produce equivalent measures of aircrew performance in both the simulator and flight environments. Therefore, the same scoring procedures should be used. This implies that the same types of measures that are generated for checklist/procedures, navigational profiles, and monitorable parameters by the simulator PMS should be generated by the airborne PMS.

The intent is thus to provide a set of processed data and measures for the establishment of statistical relationships between performance measures collected in the simulator and the aircraft.

There are currently two primary users of the raw and processed data produced by the performance measurement system. The Operations Training Division of AFHRL is concerned primarily with the establishment of relationships between simulator-based and aircraft-based performance measures. The Manpower and Personnel Division of AFHRL is interested in using the measures of crew performance as criteria in the validation of new selection procedures.

Training Needs

An investigation was conducted to determine Altus AFB training needs with respect to potential airborne PMS applications. The investigation was conducted through an examination of operational and training documentation, and through interviews with instructor pilots, instructor flight engineers, and flight examiners. The feedback provided to instructors by the simulator PMS was used as a basis for potential feedback from an airborne PMS.

The basis for the Altus training needs investigation was the Copilot Initial Qualification Course and the Flight Engineer Initial Qualification Course. The initial qualification courses consist of a sequence of several types of instructional methods. These include the use of classroom lectures, the Cockpit Familiarization Trainer (CFT), the Cockpit Procedural Trainer (CPT), the C-5 flight simulator and C-5 flights. The C-5 flight simulator training environment was addressed by the simulator PMS.

The flying phase of initial qualification training is devoted primarily to normal flying procedures. Emphasis is placed on defined normal procedures, flight safety, aircrew coordination, and aircrew standardization. Students normally receive four training flights followed by a flight evaluation. Each flight consists of pre-mission briefing, flight planning, a 4-hour flight, and post-mission activities including a mission debriefing.

Interviews with instructors were conducted to determine areas of this flying phase where an airborne PMS could enhance training needs. It was determined that the majority of debriefing or correction of errors was accomplished immediately when the error occurred. The ground mission debriefing highlights only the more serious errors or discusses alternate techniques. The instructors did not feel that a post-mission summary of checklist execution or parameter value maintenance would be useful. Most instructor pilots, however, expressed an interest in a graphic representation of the approaches flown. The instructors stressed that, to be useful, the PMS data must be available for the post-mission debriefing.

Additional Needs

In addition to the R&D and training requirements, several other uses of an airborne PMS were identified. Statistical data gathered over the running of several training missions would be useful to both personnel at MAC headquarters and to course development personnel. The data can

identify course areas which are weak and require more training, as well as areas for which there may be too much training. An airborne PMS would provide the capability to measure pilot performance in the aircraft as it is done in the simulator. Such measurements would allow analysis of the transfer of training from the simulator to the airplane. It would provide a vehicle to determine those tasks which can be entirely simulator trained and not required in airborne training.

Definition of Airborne Nominal Mission

The R&D and training needs described above established the user requirements of the airborne PMS. The next step was to determine the measurement requirements of the airborne system. The method employed to determine these measurement requirements was to construct an airborne nominal mission. The airborne nominal mission consists of the sequence of required tasks and crew activities typically found on the final evaluation flight of the Copilot Initial Qualification Course. It is constructed utilizing the syntax and format defined for the mission generation program which is employed by the simulator performance measurement system. The original intent was to design an airborne nominal mission which was equivalent to the already defined simulator nominal mission. Comparison of the resulting missions would then allow evaluation of the equivalence of the missions and definition of the differences between the missions. It was soon recognized, however, that the simulator PMS nominal mission was not compatible with the approach to airborne training.

The simulator PMS nominal mission is defined with takeoff from one airfield, flight cross country, and a landing at another airfield. Airborne training is conducted at a single airfield utilizing a series of touch-and-go landings. The study approach was modified and an airborne PMS nominal mission was defined in accordance with airborne flight training requirements. At the same time a simulator nominal mission was defined which is both "equivalent" to the airborne mission and also corresponds to the final simulator training session prior to flight training. The simulator version includes malfunctions, but the scoring of comparable normal checklists should not be affected. This approach provides simulator training and flight training with compatible missions and achieves the objectives of the airborne PMS to measure equivalent types of tasks and crew activities. Appendix A is a listing of the defined airborne nominal mission illustrating the monitored activities. Appendix B is a listing of the defined simulator nominal mission which corresponds to the airborne nominal mission.

The two nominal missions, simulator and airborne, are similar in design. The task and crew activities in both are based on respective Altus AFB training requirements and AFHRL R&D requirements. They both are flown from Altus AFB and use runway 35 as the primary runway; they commence with the aircraft on the ground. In each case, all the normal checklists, with the exception of After Takeoff Climb, Cruise, and Descent, are monitored. The Before Landing checklist is monitored before each landing. The standard list of parameters is monitored for both missions. Both missions contain a like sequence of navigational profiles to be used for touch-and-go landings. Both missions terminate with a full-stop landing.

Two main areas of difference exist between the simulator and airborne nominal missions. The first, as mentioned earlier, is in the area of malfunctions. The airborne nominal mission contains no planned malfunctions. An exception to this is the loss of one engine, which is simulated by placing the throttle to idle. All other emergencies are only talked through. In the simulator mission actual malfunctions are inserted and the associated checklists are monitored and assessed.

Another area of mission difference is the availability of mission setup data. In the simulator mission, a series of values associated with aircraft configuration, told card worksheet, and weather are specified in advance for PMS use. These data are used in mission initialization and in the monitoring of some checklists and procedures. These data can be held constant for each simulator mission but vary for each real airborne mission flown. Therefore, such setup data cannot be specified during mission definition of the airborne mission and must be provided after the mission is flown. Along this same line, all simulator nominal missions use runway 35, whereas airborne nominal missions may use either runway 35 or runway 17 as dictated by daily weather conditions. When runway 17 is used, a direct comparison cannot be made with the simulator mission in regard to navigational profiles without changing the simulator mission profile. Checklist and parameter comparisons would still be valid.

Another area should also be considered when the airborne and simulator nominal missions as defined are compared. Although both missions contain the same types of navigational profiles and checklists, the order of execution and the number of times executed are dependent on several factors. Therefore, it is unlikely that summary level scores (mission, all checklists, pilot total, etc.) will be comparable. At an individual task level (e.g., Before Landing Checklist), however, the scores are comparable.

Required Functional Capabilities

The initial activities of Phase I of the effort were directed toward definition of the needs, both training and R&D, of an airborne performance measurement system. An analysis of these R&D and training needs of AFHRL and Altus AFB, respectively, combined with an analysis of the airborne nominal mission served as the basis for the definition of the required functional capabilities of the airborne performance measurement system. The analysis of the functional capabilities considered the following areas: (a) scope, in terms of flight tasks and parameters, (b) data storage, (c) data display, retrieval, and analysis, (d) compatibility with simulator PMS, and (e) instructor data entry.

Scope of Airborne Measurement Capability. The scope of the airborne performance measurement capability can be defined in terms of aircrew tasks identified in the airborne nominal mission, as defined in Appendix A, and the airplane data associated with these tasks. The airborne mission was defined to be compatible with a corresponding simulator mission so that equivalent measurement indices could be obtained. The mission is designed to quantify operational activities required of the various crew members while performing their inflight duties during a typical training flight.

The tasks defined are delineated under the phases associated with aircraft operation for flight training. These phases are oriented toward preflight, takeoff, approach, and landing. They are described in terms of exactly two distinct crew positions: copilot and flight engineer. The aircrew tasks that are to be measured fall into three classes under the PMS concept: (a) normal checklists/procedures, (b) navigational profiles, and (c) monitorable parameters.

The airborne PMS nominal mission will monitor a total of 32 checklists and procedures as listed below. The flight engineer interior checklist is divided into eight parts for PMS purposes due to its length and complexity.

Pilot/Copilot	Flight Engineer
Before Starting Engines	Before Interior
Starting Engines	Interior - Steps 1 to 15
Before Taxi	Interior - Steps 16 to 30
Taxi	Interior - Steps 31 to 37
Before Takeoff	Interior - Steps 38 to 60
Lineup	Interior - Steps 61 to 66
Takeoff Throttle Setting	Interior - Steps 67 to 73
Approach	Interior - Steps 74 to 80
Before Landing	Interior - Steps 81 to 105
Landing	Before Starting Engines
After Landing	Starting Engines
Engine Shutdown	Before Taxi
Before Leaving Airplane	Before Takeoff
	Standard Fuel Management
	Approach
	Before Landing
	After Landing
	Engine Shutdown
	Before Leaving Airplane

Three types of navigational profiles are defined in the nominal mission to monitor the ability of the crew to adhere to predefined approach profiles:

1. Instrument Departure
2. Initial Approach and Non-Precision Final
3. Instrument Landing System Precision Final

The airborne nominal mission is defined to monitor the standard list of monitorable parameters. These measure the ability of the crew to maintain airplane systems within predefined limits during various phases or envelopes of operation. The standard list of monitorable parameters is as follows:

25 and 75 Liter Oxygen Quantity
AC Frequency Meter
AC Voltmeter
Airspeed
Angle of Attack
Cabin Flight Altitude

Cabin Pressure Difference
CSD 1, 2, 3, 4, Oil Temperature
DC Voltmeter
Engine 1, 2, 3, 4 EPR
Engine 1, 2, 3, 4 Fuel Flow
Engine 1, 2, 3, 4 Oil Pressure
Engine 1, 2, 3, 4 Oil Temperature
Engine 1, 2, 3, 4 N2 RPM
Engine 1, 2, 3, 4 TIT
Flap Position
Left, Right Manifold Pressure
Landing Gear Lever
Left, Right APU Exhaust Gas Temperature
Landing Gear Position
Mach
Magnetic Heading
Pitch
Roll
Yaw
System 1, 2, 3, 4 Hydraulic Pressure

Each of the tasks listed above (checklist/procedures, navigational profiles, monitorable parameters) was analyzed to determine the C-5 data required to measure completely the performance of the aircrew. Since each of these tasks was previously defined for the simulator PMS, their definitions were used as the basis for the analysis. The data fell into two classes. The first class is the data required to perform the actual measurement. The second class is data used to define conditions to determine when to start and stop the measurement of each task. A summary of the results of this analysis follows.

To monitor the defined checklists requires that 411 distinct signal values be extracted from the airplane. Monitoring of navigational profiles requires 40 values, and 121 values are required for monitorable parameters. There is some overlap among the three classes of tasks, so that 494 total signal values must be extracted from the airplane to monitor completely the airborne nominal mission as defined in Appendix A.

The signals required for airborne monitoring are presented in Appendices D through H. These appendices contain:

Appendix D - Code reference for Appendix E through Appendix H
Appendix E - Signals required for airborne monitoring
Appendix F - Signals required for individual checklists
Appendix G - Signals required for individual parameters
Appendix H - Signals required for navigational profiles

Data Storage Requirements. The amount of storage required to maintain the data extracted from the simulator is a function of several factors. The requirements for the ground-based processing for the airborne PMS are a direct result of the airborne recording requirements; therefore, the storage analysis was done for the airborne recording system alone.

The basic cycle rate required for data extraction is assumed to be 0.8 second. This corresponds to the current simulator PMS. A typical flight training mission covers a 4-hour period. Due to the nature of the training involving many takeoffs and approaches, signal values will change with a high frequency. Some form of filtering or trending algorithm must be applied to the data to reduce the amount of data ultimately recorded.

Table 1 depicts the amount of data storage required for a typical mission. The actual amount of recorded data is dependent on two factors: the percentage of total signals that changes every recording interval and the number of bytes required to record each item. For example, if an average of three percent of the signals changed every recording interval and five bytes are required to record each item, then 1,333,800 bytes of data storage would be required for a 4-hour mission.

Table 1. AIRBORNE NOMINAL MISSION DATA STORAGE REQUIREMENTS

% items changing in .8 sec	Number of items in .8 sec	Number of items in 4 hrs	Number of bytes per item			
			3	4	5	6
1	5	88,920	266,760	355,680	444,600	533,520
2	10	177,840	533,520	711,360	889,200	1,067,040
3	15	266,760	800,280	1,067,040	1,333,800	1,600,560
4	20	355,680	1,067,040	1,422,720	1,778,400	2,134,080
5	25	444,600	1,333,800	1,778,400	2,223,000	2,667,600
10	49	889,200	2,667,600	3,556,800	4,446,000	5,335,200
25	124	2,223,000	6,669,000	8,892,000	11,115,000	13,338,000
50	247	4,446,000	13,338,000	17,784,000	22,230,000	26,676,000
75	371	6,669,000	20,007,000	26,676,000	33,345,000	40,014,000
100	494	8,892,000	26,676,000	35,568,000	44,460,000	53,352,000

Data Display, Retrieval, and Analysis Requirements. The ultimate goal of the airborne PMS is to produce objective measures of performance which can be compared against such measures from other airborne missions or against equivalent measures from the simulator PMS. Creating such equivalent measures is easiest if, to the greatest extent possible, both airborne and simulator PMSs monitor, score, and analyze crew performance in the same fashion. The following discussion traces the path of monitored crew data through the simulator performance measurement system.

The simulator PMS monitors the aircrew performance against procedures and standards established for the mission by the mission designers. During a mission PMS logs, to a disk file, data on checklist step execution, average aircraft parameter errors, and navigational profile adherence. At mission's end a debriefing program then serves two purposes. First, it scores achieved performance recorded in the mission log against predefined standards and

scoring criteria. It then produces a printout containing computed scores and summaries. Second, in addition, the program records all scoring parameters in a Proficiency Assessment Records (PAR) disk file. The printout becomes both a hardcopy debriefing device for instructors and a conveniently organized reference for subsequent scoring data analysis.

The simulator PMS also provides for the retrieval of an arbitrary set of scoring data from any union of PAR files into a Retrieved Data File (RDF). PMS further provides statistical analysis of these retrieved data. At present the analysis is limited to descriptive statistics. The analysis program also reorganizes summary data into a format suitable for shipment to AFHRL for further analysis.

At minimum, the airborne PMS should produce assessment data in standard PAR file format. Such data can simply be processed directly by the existing PMS retrieval and analysis programs. Comparison of simulator and airborne performance would then be a matter of merely combining the proper files for analysis.

Even more desirable from a hardware/software compatibility viewpoint would be an airborne PMS whose monitoring output was in PMS log-file format. The PMS debriefing program could then process the log, producing both standard PAR files and some form of debriefing report. Again, such a report would be useful both to instructors and to mission analysts, although the timeliness of such a report for mission debriefing is problematical.

Regarding airborne display requirements, the airborne PMS will generate no real-time displays, either of performance feedback or geographic track history. However, ground-based post-mission processing could produce hardcopy graphics of the navigational profiles flown in the mission. Such graphics would momentarily appear on a CRT display for transfer to the hardcopy medium.

Compatibility Requirements with Simulator PMS. A critical consideration in designing an airborne PMS to fulfill the goals of the overall program is the compatibility of the airborne and simulator PMS designs. In order to provide the means to analyze equivalent measures from simulator and airborne missions, it is advantageous for the two systems to have common data paths in their processing as early as possible. The previous sections recommended that this point of commonality be the mission log file. Commonality is also enhanced if the system which processes the airborne recorded data utilizes the same algorithms and programs developed for the simulator PMS.

Instructor Data Entry Requirements. The simulator PMS provides two methods to start the monitoring of performance tasks: automatic and manual. The automatic method starts monitoring a task when mission-specified start conditions have been satisfied. These start conditions can include completion "links" from checklists, execution of a checklist step, geographical position, etc. The manual method allows the instructor to start a task (checklist/procedure, navigational profile, monitorable parameter) from a keyboard attached to the PMS.

The airborne PMS will require similar indications to the ground-based processing system as to when to start monitoring a task. If enough signals could be acquired from the airplane, then automatic monitoring start of checklists/procedures and monitorable parameters would be possible. Navigational profile start is less easy to identify, as all profiles in the airborne mission basically start in the same general location and can appear in random order. This is also true for the equivalent simulator nominal mission, unless the instructor/mission designer predetermines the exact sequence of profiles.

Therefore, an on-board entry device is required for instructor entry of annotation of the start of certain events. As a minimum, this must include the designation of the type of navigational profile being flown and when to start the monitoring. This device could also be used to start manually monitoring checklists and parameter envelopes at the command of the instructor.

The on-board entry device must be as simple to operate as possible. This is necessary so as not to add to the workload nor distract the instructor from the safe operation of the aircraft. The output of the on-board entry device must be recorded on the PMS recording device for use by the ground-based processing system.

Recording Capability of C-5. The subsystems of the C-5 aircraft were analyzed to determine existing capabilities to provide recorded data for use by the airborne PMS system. The only system which already records aircraft data in a reasonable form for extraction of data is the Malfunction Detection, Analysis and Recording System (MADARS). The potential use of the MADARS is complicated by the planned replacement of this equipment in the near future.

The MADARS is a computerized data collection, processing, and recording system. The express purpose of MADARS is to assist the flight engineer and ground crews in checking airplane line replaceable units and subsystems for degradation or failure. The data collected by MADARS is also used to establish long-term failure trends to improve spares logistic support, as well as provide a useful tool for maintenance troubleshooting.

The data collection part of MADARS has 22 signal amplifier units located throughout the C-5A aircraft. Each amplifier has the capacity for 29 analog inputs and upon command, it selects one of 29 parallel analog input signals and transmits it to a central multiplexer. The central multiplexer controls the multiplexing of the signal amplifiers and digitizes the analog signals for computer operation.

The data collected by MADARS from the signal amplifiers are used in two ways. The MADARS computer programs analyze the data collected to determine the status of airplane systems. When a fault is detected, the flight engineer is notified and/or a fault code entry is made on the Maintenance Data Recorder (MDR). In addition, the MADARS computer performs a trend analysis of selected data values.

In the trend analysis, data are recorded only when the signal value changes by more than a predefined variance from an established baseline. When the signal values go out of the defined bounds, the signal value is recorded on the magnetic tape and established in the computer as the new baseline. The allowable variance for each signal is pre-assigned and is based on the usage of the recorded values. As an example of this trending operation, assume a mach number of .600 with an allowable variance of $\pm$ .010. A change in value of the function will not be recorded until it goes outside the .59 to .61 boundary range. If the value jumps to .612, then this value is recorded on the magnetic tape and established in the computer as the new base. The computer now uses .602 and .622 as the new boundary limits. This technique allows many functions to be monitored with a limited amount of recording speed and tape storage. Since the signals are all monitored at least once per second, the trending operation produces a representative monitoring of all functions.

An analysis was performed on the current MADARS to determine what signals are currently recorded or could be recorded with program modifications to support to airborne PMS data extraction requirements. Approximately 72 of the 494 signals required for the airborne PMS can be made available.

The potential MADARS signals are:

Air Conditioning Switch
ALDCS Switch
Altitude
Cargo Switch
Co-Pilot Altitude
Engine 1 - A/I Switch
- Bleed Air Switch
- EPR
- Fuel Flow
- Fuel Heater Switch
- N1 RPM
- N2 RPM
- Oil Pressure
- Oil Temperature
- TIT

Engine 2 - A/I Switch
- Bleed Air Switch
- EPR
- Fuel Flow
- Fuel Heater Switch
- N1 RPM
- N2 RPM
- Oil Pressure
- Oil Temperature
- TIT

Engine 3 - A/I Switch
- Bleed Air Switch
- EPR

Engine 4 - A/I Switch
- Bleed Air Switch
- EPR
- Fuel Flow
- Fuel Heater Switch
- N1 RPM
- N2 RPM
- Oil Pressure
- Oil Temperature
- TIT

Flap Position Indicator
Flight Station Switch
Floor Heat Switch
Generator Volts and Frequency Switch
Ground Spoiler Handle
Left Flow Control Switch
Left Manifold Pressure
Landing Gear Lever
Left APU EGT Indicator
Lateral Augmentation Switch
Mach
On-Ground Indicator
Pilot Altitude
Pitch Augmentation Switch
Right Flow Control Switch
Right Manifold Pressure
Right APU EGT Indicator
Relief Crew Switch

- Fuel Flow
- Fuel Heater Switch
- N1 RPM
- N2 RPM
- Oil Pressure
- Oil Temperature
- TIT

Throttle 1 Position
Throttle 2 Position
Throttle 3 Position
Throttle 4 Position
Total Fuel Quantity
Troop Compartment Switch
Vertical Accelerometer
Yaw Augmentation Switch

Preliminary indications of the replacement MADARS show that it will have about the same capability. The majority of the missing signals are discrete switch positions required for checklist monitoring.

Other airplane systems have available some of the remaining required signals, but have no means of recording them for ground processing. The most notable of these systems are the Inertial Navigation System (INS) and the Flight Director Computer (FDC). Between them they provide another 14 signals required for the airborne PMS.

The potential FDC signals are:

Copilot Course Deviation Indicator
Copilot Course Deviation Indicator Warning
Copilot Glideslope Deviation Indicator
Copilot Glideslope Deviation Warning
Copilot Navigation Select
Pilot Course Deviation Indicator
Pilot Course Deviation Indicator Warning
Pilot Glideslope Deviation Indicator
Pilot Glideslope Deviation Warning
Pilot Navigation Select
TACAN DME

The potential INS signals are:

Bank
Latitude
Longitude

As can be seen, the percentage of available airplane signals for optimal PMS processing is not large and is insufficient to fulfill the goals of the airborne PMS. The analysis of this deficiency and the definition of alternate design approaches were accomplished in Phase II of this effort. The results are described in the next section.

SECTION III

PHASE II - ALTERNATIVES

Phase I of the effort established the data requirements for the airborne performance measurement system that was equivalent in concept to the currently operational C-5A simulator performance measurement system. This phase involved an analysis of the required signal data base, an analysis of currently available signals, and an investigation of feasible alternate signal sources. These analyses resulted in the definition of alternative design approaches that could be taken to achieve an airborne PMS capability. This phase concluded with the presentation of an interim briefing for AFHRL and Altus AFB representatives. The interim briefing presented the findings of the needs analysis and the C-5 recording capability analysis. It also presented alternative design approaches for a C-5 airborne performance measurement system. Based on guidelines received at the conclusion of the briefing, the design approach presented in Section IV was formulated.

Parameter Analysis

The investigation of the recording capability of the C-5 resulted in a listing of 72 signals that could be obtained, either currently or with software modifications, from the MADARS. In addition, another 14 signals were designated as being potentially available from the INS and the FDC. These signals provide approximately 17 percent of the 494 signals required to do airborne performance measurement equivalent to the simulator performance measurement system.

The applicability of the available signals to PMS monitorable tasks is defined in Appendices F, G, and H. Very few tasks can obtain enough data to make a valid measurement. Table 2 summarizes the signal requirements for checklists, Table 3 for monitorable parameters, and Table 4 for navigational profiles. Table 5 presents a summary of total signal requirements.

The majority of the missing parameters are indications of discrete switch positions. These are used primarily in the monitoring of checklist execution. A small number of continuous or analog signals are also not readily obtainable. These signals are also used in checklist evaluation as well as the evaluation of navigational profiles and monitorable parameters.

An investigation was conducted of the C-5 airplane systems to attempt to find sources for the missing signals. The previously mentioned INS and FDC provide a wide range of signals related to the control of the aircraft during flight. Fourteen of these signals were identified as being useful for airborne performance measurement monitoring. The breakouts to these two systems to allow for data extraction are fairly simple in design. No other systems were discovered which could provide signals with simple airplane modifications.

Table 2. CHECKLIST SIGNAL REQUIREMENTS

INDEX	CHECKLIST	NUMBER SIGNALS	MALFUNC -TIONS	INITIAL /SETUP	AIRPLANE REQUIRED	MADAR	OTHER SOURCES	AVAIL -ABLE	UNAVAIL -ABLE
C.03	FE - AFTER LANDING	55	3	0	52	2	0	2	50
C.04	P - AFTER LANDING	12	0	0	12	3	0	3	9
C.10	FE - APPROACH	22	1	0	21	5	0	5	16
C.11	P - APPROACH	8	0	0	8	1	0	1	7
C.12	FE - BEFORE INTERIOR	71	2	1	68	2	0	2	66
C.13	FE - BEFORE LANDING	3	0	0	3	1	0	1	2
C.14	P - BEFORE LANDING	7	0	1	6	2	0	2	4
C.19	FE - BEFORE LEAVING AIRPLANE	20	0	0	20	1	0	1	19
C.20	P - BEFORE LEAVING AIRPLANE	5	0	0	5	0	0	0	5
C.21	FE - BEFORE STARTING ENGINES	49	6	0	43	2	0	2	41
C.22	P - BEFORE STARTING ENGINES	17	0	0	17	8	0	8	9
C.23	FE - BEFORE TAKE OFF	4	0	0	4	0	0	0	4
C.24	P - BEFORE TAKE OFF	13	0	1	12	3	0	3	9
C.25	FE - BEFORE TAXI	23	4	0	19	5	0	5	14
C.26	P - BEFORE TAXI	14	8	0	6	4	0	4	2
C.44	FE - ENGINE SHUTDOWN	53	0	0	53	5	0	5	48
C.45	P - ENGINE SHUTDOWN	14	0	0	14	3	0	3	11
C.56	FE - INTERIOR (1- 15)	29	0	0	29	1	0	1	28
C.57	FE - INTERIOR (16- 30)	52	0	1	51	16	0	16	35
C.58	FE - INTERIOR (31- 37)	61	0	0	61	4	0	4	57
C.59	FE - INTERIOR (38- 60)	49	0	0	49	1	0	1	48
C.60	FE - INTERIOR (61- 66)	10	0	0	10	1	0	1	9
C.61	FE - INTERIOR (67- 73)	24	0	0	24	1	0	1	23
C.62	FE - INTERIOR (74- 80)	32	0	0	32	1	0	1	31
C.63	FE - INTERIOR (81-105)	27	0	0	27	0	0	0	27
C.64	P - LANDING	11	0	1	10	6	0	6	4
C.68	P - LINEUP	21	0	0	21	5	0	5	16
C.91	FE - STANDARD FUEL MANAGEMENT	50	2	1	47	2	0	2	45
C.92	FE - STARTING ENGINES	73	4	0	69	14	0	14	55
C.93	P - STARTING ENGINES	33	8	0	25	8	0	8	17
C.94	P - TAKEOFF THROTTLE SETTING	19	1	1	17	15	0	15	2
C.95	P - TAXI	1	0	0	1	0	0	0	1
	TOTAL	448	32	5	411	48	0	48	363

Table 3. PARAMETER SIGNAL REQUIREMENTS

INDEX	PARAMETER	NUMBER SIGNALS	MALFUNC -TIONS	INITIAL /SETUP	AIRPLANE REQUIRED	MADAR	OTHER SOURCES	AVAIL -ABLE	UNAVAIL -ABLE
P.01	25 LITER OXYGEN QUANTITY IND	2	0	0	2	1	0	1	1
P.02	75 LITER OXYGEN QUANTITY IND	2	0	0	2	1	0	1	1
P.03	AC FREQUENCY METER	17	0	0	17	1	0	1	16
P.04	AC VOLTMETER	14	0	0	14	5	0	5	9
P.05	AIRSPEED	20	0	10	10	4	0	4	6
P.06	ANGLE OF ATTACK	2	0	0	2	1	0	1	1
P.07	CABIN FLIGHT ALTITUDE	3	1	0	2	0	0	0	2
P.08	CABIN PRESSURE DIFFERENCE	3	1	0	2	0	0	0	2
P.09	CSD1 OIL TEMPERATURE	3	0	0	3	0	0	0	3
P.10	CSD2 OIL TEMPERATURE	3	0	0	3	0	0	0	3
P.11	CSD3 OIL TEMPERATURE	3	0	0	3	0	0	0	3
P.12	CSD4 OIL TEMPERATURE	4	1	0	3	0	0	0	3
P.13	DC VOLTMETER	2	0	0	2	0	0	0	2
P.14	ENGINE 1 EPR	7	0	2	5	4	0	4	1
P.15	ENGINE 1 FUEL FLOW	4	0	0	4	2	0	2	2
P.17	ENGINE 1 N2 RPM	2	0	0	2	1	0	1	1
P.18	ENGINE 1 OIL PRESSURE	4	0	0	4	3	0	3	1
P.19	ENGINE 1 OIL TEMPERATURE	2	0	0	2	1	0	1	1
P.21	ENGINE 1 TIT	1	0	0	1	1	0	1	0
P.22	ENGINE 2 FUEL FLOW	4	0	0	4	2	0	2	2
P.23	ENGINE 2 N2 RPM	2	0	0	2	1	0	1	1
P.24	ENGINE 2 OIL PRESSURE	4	0	0	4	3	0	3	1
P.25	ENGINE 2 OIL TEMPERATURE	2	0	0	2	1	0	1	1
P.26	ENGINE 2 EPR	7	0	2	5	4	0	4	1
P.29	ENGINE 2 TIT	1	0	0	1	1	0	1	0
P.30	ENGINE 3 EPR	7	0	2	5	4	0	4	1
P.31	ENGINE 3 FUEL FLOW	4	0	0	4	2	0	2	2
P.33	ENGINE 3 OIL PRESSURE	4	0	0	4	3	0	3	1
P.34	ENGINE 3 OIL TEMPERATURE	2	0	0	2	1	0	1	1
P.35	ENGINE 3 N2 RPM	2	0	0	2	1	0	1	1
P.37	ENGINE 3 TIT	1	0	0	1	1	0	1	0

Table 3. PARAMETER SIGNAL REQUIREMENTS (Concluded)

INDEX	PARAMETER	NUMBER SIGNALS	MALFUNC -TIONS	INITIAL /SETUP	AIRPLANE REQUIRED	MADAR	OTHER SOURCES	AVAIL -ABLE	UNAVAIL -ABLE
P.38	ENGINE 4 EPR	7	0	2	5	4	0	4	1
P.39	ENGINE 4 OIL PRESSURE	4	0	0	4	3	0	3	1
P.40	ENGINE 4 OIL TEMPERATURE	2	0	0	2	1	0	1	1
P.41	ENGINE 4 FUEL FLOW	4	0	0	4	2	0	2	2
P.43	ENGINE 4 N2 RPM	2	0	0	2	1	0	1	1
P.44	ENGINE 4 TIT	1	0	0	1	1	0	1	0
P.47	FLAP POSITION INDICATOR	8	2	1	5	2	0	2	3
P.54	LEFT MANIFOLD PRESSURE	5	0	0	5	3	0	3	2
P.55	LANDING GEAR LEVER	3	0	1	2	2	0	2	0
P.56	LEFT APU EGT INDICATOR	4	0	0	4	2	0	2	2
P.57	MACH	5	0	0	5	2	0	2	3
P.58	MAGNETIC HEADING	5	0	1	4	3	0	3	1
P.63	MLG POSITION INDICATOR, LA	5	0	2	3	1	0	1	2
P.64	MLG POSITION INDICATOR, LF	5	0	2	3	1	0	1	2
P.65	MLG POSITION INDICATOR, RA	5	0	2	3	1	0	1	2
P.66	MLG POSITION INDICATOR, RF	5	0	2	3	1	0	1	2
P.68	NLG POSITION CROSSWIND IND	5	0	2	3	1	0	1	2
P.69	NLG STEERING INDICATOR	8	2	3	3	1	0	1	2
P.71	PITCH	6	0	1	5	2	0	2	3
P.73	RIGHT MANIFOLD PRESSURE	5	0	0	5	3	0	3	2
P.74	RIGHT APU EGT INDICATOR	4	0	0	4	2	0	2	2
P.75	ROLL	6	0	2	4	1	0	1	3
P.76	SYSTEM 1 HYDRAULIC PRESSURE	6	0	0	6	1	0	1	5
P.77	SYSTEM 2 HYDRAULIC PRESSURE	8	0	0	8	1	0	1	7
P.78	SYSTEM 3 HYDRAULIC PRESSURE	8	0	0	8	1	0	1	7
P.79	SYSTEM 4 HYDRAULIC PRESSURE	6	0	0	6	1	0	1	5
P.84	YAW	2	0	0	2	1	0	1	1
	TOTAL	148	6	21	121	44	0	44	77

Table 4. NAVIGATIONAL PROFILE SIGNAL REQUIREMENTS

NAVIGATIONAL PROFILE	NUMBER SIGNALS	MALFUNC -TIONS	INITIAL /SETUP	AIRPLANE REQUIRED	MADAR	OTHER SOURCES	AVAIL -ABLE	UNAVAIL -ABLE
INSTRUMENT DEPARTURE	41	0	9	32	4	10	14	18
INITIAL APPROACH	36	0	8	28	1	9	10	18
INSTRUMENT LANDING SYSTEM(ILS)	30	0	6	24	2	12	14	10
TOTAL	55	0	15	40	4	14	18	22

Table 5. SIGNAL REQUIREMENT SUMMARY

TASK	NUMBER SIGNALS	MALFUNC -TIONS	INITIAL /SETUP	AIRPLANE REQUIRED	MADAR	OTHER SOURCES	AVAIL -ABLE	UNAVAIL -ABLE
CHECKLIST	448	32	5	411	48	0	48	363
MONITORABLE PARAMETER	148	6	21	121	44	0	44	77
NAVIGATIONAL PROFILES	57	0	15	42	4	15	19	23
TOTAL				494	72	14	86	408

The simulator performance measurement system extracts data from the simulator system using a specially designed piece of equipment, the Data Acquisition and Control System (DACS). It allows the simulator PMS computer to acquire and control specific simulator data. The DACS serves to set up and control the simulator for a defined mission, insert and remove malfunctions, and monitor aircrew performance data. This technique makes it possible to monitor directly or indirectly all mission events that occur from the start of preflight to the termination of the mission, since all such event signal data are processed by the simulator computer and pass through a common input/output interface. A central processing interface of this nature does not exist on the C-5 aircraft.

At the initiation of the effort it was anticipated that the primary means of obtaining the required data would be through the MADARS. Subsequent investigation of the MADARS found it to be less than ideal for several reasons. The analysis of the currently available MADARS signals identified only two that were useable for performance monitoring. It would be possible to increase this number by adding additional signal acquisition units and modifying the MADARS program, but the airplane changes would be extensive. In addition, the extra workload on the MADARS computer could cause a degradation of current capabilities. Even more restrictive is the fact that the MADARS is not put into operation until the end of the Flight Engineer's Before Starting Engines checklist and is turned off at the beginning of the Flight Engineer's Engine Shutdown checklist. This completely precludes its ability to monitor crew performance during preflight and post-flight operations. The current MADARS also limits the recording of trend operations, continually changing values, to 11 per second. During periods of rapidly changing signals, such as takeoff and landing, signal values cannot be recorded as they change, but only when there is time. This would restrict the accuracy, timeliness, and usefulness of MADARS data.

Another approach would be the installation of a special processor/recorder unit to record the parameters required for crew evaluation. This would solve some of the restrictions of MADARS. The equipment could be designed such that it could be put into operation immediately by the flight engineer instructor on entering the aircraft and turned off just prior to exiting the airplane. This would allow the monitoring of the entire mission, including preflight and postflight. The processor selected would be powerful enough to sample and record all required signals at the correct frequency. A major problem still remains; namely, the extensive modifications to the C-5 airplane that must be made to acquire the signals. This is undesirable for two reasons. The major modifications involved in adding a PMS of this type could affect the qualifications of the aircraft flight readiness and could require extensive and expensive requalification. These modifications would be time-consuming to install and remove. The current plans are to utilize the Altus AFB training program as the source of performance measurement data. No C-5's are permanently assigned to Altus, but rather rotate there for a period of time. Therefore, a PMS system must be easy and quick to install and remove, thus effectively eliminating this approach.

At this point in the effort it was recognized that monitoring of all switch settings and mission events would be prohibitive. Therefore, the effort was redirected toward defining an airborne PMS mission that utilized the signals previously identified as available.

Airborne Navigational Profile Mission

An analysis was performed on each task of the full airborne nominal mission to determine the effect of missing signals on the ability of PMS to perform a meaningful measurement of crew performance related to that task. The results of this analysis are presented below, along with the specification of an Airborne PMS Navigational Profile Mission.

The normal checklists specified in the full airborne nominal mission require the acquisition of a large number of airplane signals to monitor the execution of all steps of the checklists. A comparison of the required signals and the available signals for each checklist shows that there are no checklists that can be completely monitored. In fact, most checklists are very sparse in the number of available signals present. Therefore, given the restrictions on extraction of airplane data, it is impossible to perform a meaningful measurement of aircrew performance in the execution of checklists.

The same type of analysis of the PMS standard list of monitorable parameters gives a similar result. With one instrument group of exceptions, no monitorable parameter definition has a sufficient number of available signals to give a meaningful analysis of crew performance. Therefore, the complete PMS standard parameter list cannot be monitored.

The final category of crew task performance comprises the execution of maneuvers related to departure, approach, and a landing. These are referred to in PMS as navigational profiles. The preliminary examination of the signals required for navigational profile monitoring also showed a large number of missing signals. Table 6 summarizes the signal requirements for this monitoring. A further analysis was performed which ranked the required signals in the order of relative importance. In addition, a further search was performed for sources for the signals with a high degree of importance. A study was then conducted on the effect of the remaining missing signals on navigational profile measurement. The result of this effort was that it is feasible to monitor navigational profiles and provide a meaningful measurement of crew performance. It was further determined that it was feasible to measure a small number of monitorable parameters related to the execution of navigational profiles.

Based on the analysis above, a new PMS nominal mission was defined and is presented in Appendix C. This nominal mission stresses the measurement of crew performance of navigational profiles. The monitoring of checklists and the standard parameter list has been removed. A small number of monitorable parameters related to the execution of navigational profiles has been added. An important point to note in this nominal mission is that there are no longer any tasks being monitored which relate to the Flight Engineer. The navigational profile nominal mission measures only a portion of the

Table 6. NAVIGATIONAL PROFILE MISSION SIGNAL REQUIREMENTS

NAVIGATIONAL PROFILE SIGNAL REQUIREMENTS

NAVIGATIONAL PROFILE	NUMBER SIGNALS	MALFUNC -TIONS	INITIAL /SETUP	AIRPLANE REQUIRED	MADAR	OTHER SOURCES	AVAIL -ABLE	UNAVAIL -ABLE
INSTRUMENT DEPARTURE	41	0	9	32	4	10	14	18
INITIAL APPROACH	36	0	8	28	1	9	10	18
INSTRUMENT LANDING SYSTEM(ILS)	30	0	6	24	2	12	14	10
TOTAL	51	0	15	36	4	14	18	18

PARAMETER SIGNAL REQUIREMENTS

INDEX	PARAMETER	NUMBER SIGNALS	MALFUNC -TIONS	INITIAL /SETUP	AIRPLANE REQUIRED	MADAR	OTHER SOURCES	AVAIL -ABLE	UNAVAIL -ABLE
P.05	AIRSPEED	20	0	10	10	4	0	4	6
P.06	ANGLE OF ATTACK	2	0	0	2	1	0	1	1
P.47	FLAP POSITION INDICATOR	8	2	1	5	2	0	2	3
P.52	GROUND SPEED	2	0	0	2	1	0	1	1
P.53	LEFT LANDING LIGHT SWITCH	1	0	0	1	0	0	0	1
P.55	LANDING GEAR LEVER	3	0	1	2	2	0	2	0
P.69	NLG STEERING INDICATOR	8	2	3	3	1	0	1	2
P.70	NOSE LANDING LIGHT SWITCH	1	0	0	1	0	0	0	1
P.71	PITCH	6	0	1	5	2	1	3	2
P.72	RIGHT LANDING LIGHT SWITCH	1	0	0	1	0	0	0	1
P.75	ROLL	6	0	2	4	1	0	1	3
P.83	VERTICAL SPEED	2	0	0	2	1	0	1	1
P.84	YAW	2	0	0	2	1	0	1	1
	TOTAL	35	4	12	19	5	1	6	13

SIGNAL REQUIREMENT SUMMARY

TASK	NUMBER SIGNALS	MALFUNC -TIONS	INITIAL /SETUP	AIRPLANE REQUIRED	MADAR	OTHER SOURCES	AVAIL -ABLE	UNAVAIL -ABLE
MONITORABLE PARAMETER	35	4	12	19	5	1	6	13
NAVIGATIONAL PROFILES	51	0	15	36	4	14	18	18
TOTAL				52	7	14	21	31

performance of the copilot: that part related to flying the airplane on predetermined flight plans for takeoff, approach, and landing.

Navigational Profile Mission Signal Requirements

In order to monitor crew performance within navigational profiles and associated monitorable parameters, the airborne PMS must acquire airplane data in six categories. The categories and their data variables are:

1. Present aircraft position:
   - Latitude
   - Longitude

2. Aircraft flight parameters:
   - Altitude
   - Altitude above ground level
   - Airspeed
   - Ground speed
   - Vertical speed
   - Rate of turn
   - Magnetic heading
   - Angle of attack
   - Wheels on ground indicator
   - Course Deviation Indicator (CDI)
   - Glideslope Deviation Indicator (GSI)
   - CDI Warning
   - GSI Warning

3. Instrument Settings:
   - Course set
   - Navigation Selection Panel

4. Control Settings:
   - Flap handle
   - Flap position indicator
   - Landing gear lever
   - Nose landing gear indicator
   - Nose landing gear steering indicator

5. Flight command signals:
   - Bank
   - Pitch
   - Roll
   - Yaw

6. Navigational aid signals:
   - ADF frequency
   - ADF function switch
   - TACAN DME
   - TACAN channel
   - TACAN mode switch
   - TACAN function switch

TACAN antenna switch
VOR frequency
VOR switch

Data Storage Requirements

The redefinition of the airborne nominal mission to a navigational profile mission reduced the measurement capability of the PMS. In addition, it also reduced the storage requirements for data being extracted from the airplane. The data storage requirements were recomputed based on the new set of required parameters and are shown in Table 7.

Table 7. NAVIGATIONAL PROFILE MISSION DATA STORAGE REQUIREMENTS

% items changing in .8 sec	Number of items in .8 sec	Number of items in 4 hours	Number of bytes per item			
			3	4	5	6
1	1	10,080	30,240	40,320	50,400	60,480
2	1	20,160	60,480	80,640	100,800	120,960
3	2	30,240	90,720	120,960	151,200	181,440
4	2	40,320	120,960	161,280	201,600	241,920
5	3	50,400	151,200	201,600	252,000	302,400
10	6	100,800	302,400	403,200	504,000	604,800
25	14	252,000	756,000	1,008,000	1,260,000	1,512,000
50	28	504,000	1,512,000	2,016,000	2,520,000	3,024,000
75	42	756,000	2,268,000	3,024,000	3,780,000	4,536,000
100	56	1,008,000	3,024,000	4,032,000	5,040,000	6,048,000

Alternative Design Approaches

Phase I of the effort and the early part of Phase II were directed to defining the requirements and capabilities of an airborne PMS. Phase II culminated with the definition of alternate design approaches for the airborne PMS. The airborne PMS is composed of two distinct systems: the airborne recording system and the ground-based processing system. The options investigated for each system are discussed separately and their combinations are considered.

Airborne Recording System. Although the conclusion was reached that it is not feasible at this time to record all the signal values required for the full airborne nominal mission, the options available to do this recording were considered. To obtain all the required signals would require extensive changes to the C-5. A connection would have to be made to each location (switch, instrument, subsystem) generating a required signal. Each location would then be wired to a central source for sampling by a computer system, either MADARS or a new system. Practical considerations would dictate a new, powerful computer system. The output of this system

could take several forms such as raw recorded data, converted data, or fully processed performance data. These data could be transferred to the ground processing system on magnetic tape, disk, or even via a data link.

The airborne recording system required for the Navigation Profile mission is much simpler in nature. This system requires the extraction of a small amount of data from a limited number of sources. This system would have a breakout connector to the INS, the FDC, and MADARS. A simple keyboard would be required for instructor entries to identify the type of profile being flown. The processor would require enough capability to sample these sources of data periodically, format the data, and record the data on a transfer medium, probably magnetic tape.

Ground-Based Processing System. The choice of a ground-based processing system is directly related to the choice of the airborne recording system. Basically, the ground processing system would receive amd process the recorded data to produce summary measures comparable to those produced by the simulator PMS. The ground-based system would process essentially as the simulator PMS does. The salient difference is that the source of data is the airborne recorded data rather than the simulator extracted data.

For all practical purposes, the current simulator PMS equipment can do this processing. An input device must be added to access the recorded data. The system will require software modifications and additions to process the airborne data properly. If, as for post-mission debriefing, rapid results are required, a duplicate of the PMS hardware suite can be used.

Recommended Design Approach. An interim briefing was held at the end of Phase II to present the findings of the study to AFHRL and Altus AFB personnel. The result of this briefing was the choice of a processing system and design approach for the airborne performance measurement system. The concept of the Navigational Profile mission was approved. A significant decision was to eliminate the requirement to support Altus training needs since the provided support appeared minimal. This decision relieved the timeliness requirement of the ground-based system and allowed the utilization of the simulator PMS equipment on an as-available basis.

A block diagram of the recommended system is given in Figure 1. This diagram illustrates the hardware elements of an airborne performance measurement system. The next section of this report will present a design specification for this system.

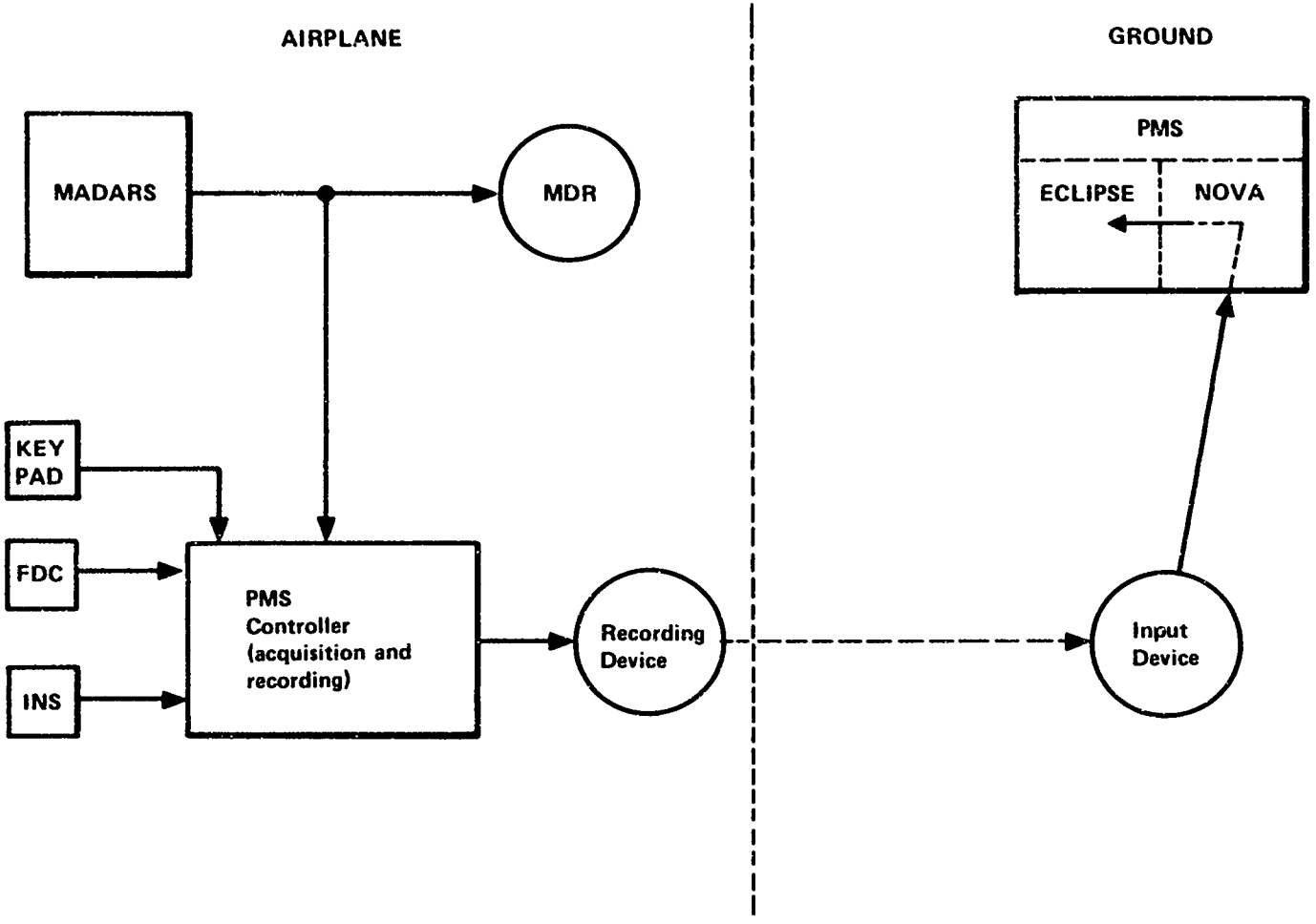

Figure 1. Recommended Airborne PMS System.

SECTION IV

PHASE III - SYSTEM DESIGN

The first two phases of this study were concerned with the investigation of the requirements for an airborne performance measurement system for C-5 aircrew members and with a search of current airplane systems for recorded and/or available signals to support these requirements. These two phases resulted in a refinement of the functional requirements for the airborne PMS and in the selection of the overall design for the airborne PMS. The task of phase III was to specify the detailed design of the selected configuration.

Airborne Performance Measurement System Requirements

The C-5 airborne performance measurement system should provide the capability to record data extracted from airplane systems. The data recorded should be sufficient to allow a computer system to analyze the data and provide a measurement of aircrew performance related to the task of flying profiles during the takeoff and landing phases of flight operations. The output of the airborne PMS should be in a format compatible with that currently output by the simulator PMS to allow comparison of equivalent indices of performance measurement.

Four factors will be considered for the airborne PMS design. The changes to the C-5 aircraft should be as few as possible. The airborne recording portion should be portable and require a minimum amount of effort to install and remove. The workload imposed on the instructor should be minimal. Lastly, the ground-based portion should utilize the current simulator PMS.

Airborne PMS System Design

The airborne PMS will be composed of the airborne recording system and the ground-based processing system. The interface between these two subsystems will be a medium for transferring data recorded in the airplane to the ground for processing. This concept is illustrated in Figure 2.

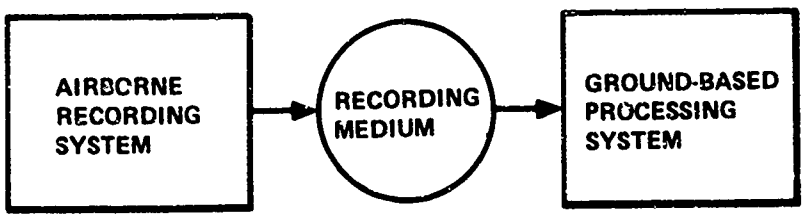

Figure 2. Airborne PMS Subsystems.

The following sections will describe the functional, hardware, and software requirements of these two subsystems.

Airborne Recording Design Specification

The airborne recording system will be designed as an attachment to the C-5 airplane. The design will ensure that there is no interference to the airplane operation or safety. The system will allow for easy installation and removal for utilization on several C-5 airplanes.

Functional Requirements. The functional requirements of the airborne PMS are defined based on four criteria:

1. The necessary aircraft signal data
2. The means to acquire and record these signals
3. The sampling rate for each signal
4. The means whereby appropriate instructor annotation can be made

Section III of this report defined a list of signal data that must be acquired from the C-5 to monitor and measure crew performance related to navigational profiles and associated monitorable parameters. It was determined that not all of these signals are readily available from C-5 subsystems. Analysis also determined that the missing signals would not adversely affect the ability to measure crew performance as defined by the airborne navigational profile mission.

The following signals can be obtained from the indicated airplane subsystems:

Inertial Navigation System (INS)
- Bank
- Latitude
- Longitude
- Roll

Flight Director Computer (FDC)
- Course Deviation Indicator (CDI)
- CDI Warning
- Glideslope Deviation Indicator (GSI)
- GSI Warning
- Navigational Select Panel
- Pitch
- TACAN DME

Malfunction Detection, Analysis, and Recording System (MADARS)
- Flap Position Indicator
- Landing Gear Lever
- On-Ground Indication

The above data will be sampled at a rate of 0.8 second to remain compatible with the ground-based processing system cycle rate. The data will be recorded whenever a change is detected, although it should be permissible to define

a delta change for each parameter before recording takes place. All recorded data will be mission time-tagged.

A means will be provided for the instructor to annotate or identify the output data. This annotation will be limited to identification of the type of approach being flown.

Hardware Requirements. The hardware for the airborne recording system must be rugged, portable, and easily removed and installed. The system must not affect any of the aircraft systems to which it may be attached, either directly or indirectly. In operation, the system must require a minimum of intervention on the part of the instructor. An analysis of the functional requirements developed the following suggested hardware design. The hardware consists of five major units. A block diagram of the hardware is illustrated in Figure 3. The hardware subsystems are:

1. PMS Controller
2. Cartridge Tape Drive
3. Instructor Keypad and Display
4. MADARS Tape Interface (MIL-1553B)
5. INS and FDC Breakout Lines

The PMS Controller is the actual airborne processor responsible for acquiring and processing all data for later use. It will receive inputs from the instructor keypad, the FDC, the INS and the output of the existing MADARS system (obtained between the MADARS system and the MADARS tape drive).

The controller will be mounted in an aluminum instrument case, which will also contain the cartridge tape drive and provide a storage area for interface cables and the instructor keypad. The controller will consist of the following six functional units as illustrated in Figure 4:

1. Single Board Computer. A 16-bit computer which will perform data trending, I/O control, data formatting and related processing tasks for the airborne PMS controller.

2. Tape I/O Controller. This unit performs all "housekeeping" tasks related to the cartridge tape drive, such as Start, Stop, Record, etc.

3. Serial I/O. This unit performs all communication between the PMS controller and the Instructor Keypad.

4. FDC I/O. This unit receives data from the FDC breakout connection and converts the data into a format acceptable to the single board computer. Additionally, it serves to provide isolation between the controller and the FDC.

5. INS I/O. This unit receives data from the INS breakout connection and converts the data into a format acceptable to the single board computer. Additionally, it serves to provide isolation between the controller and the INS.

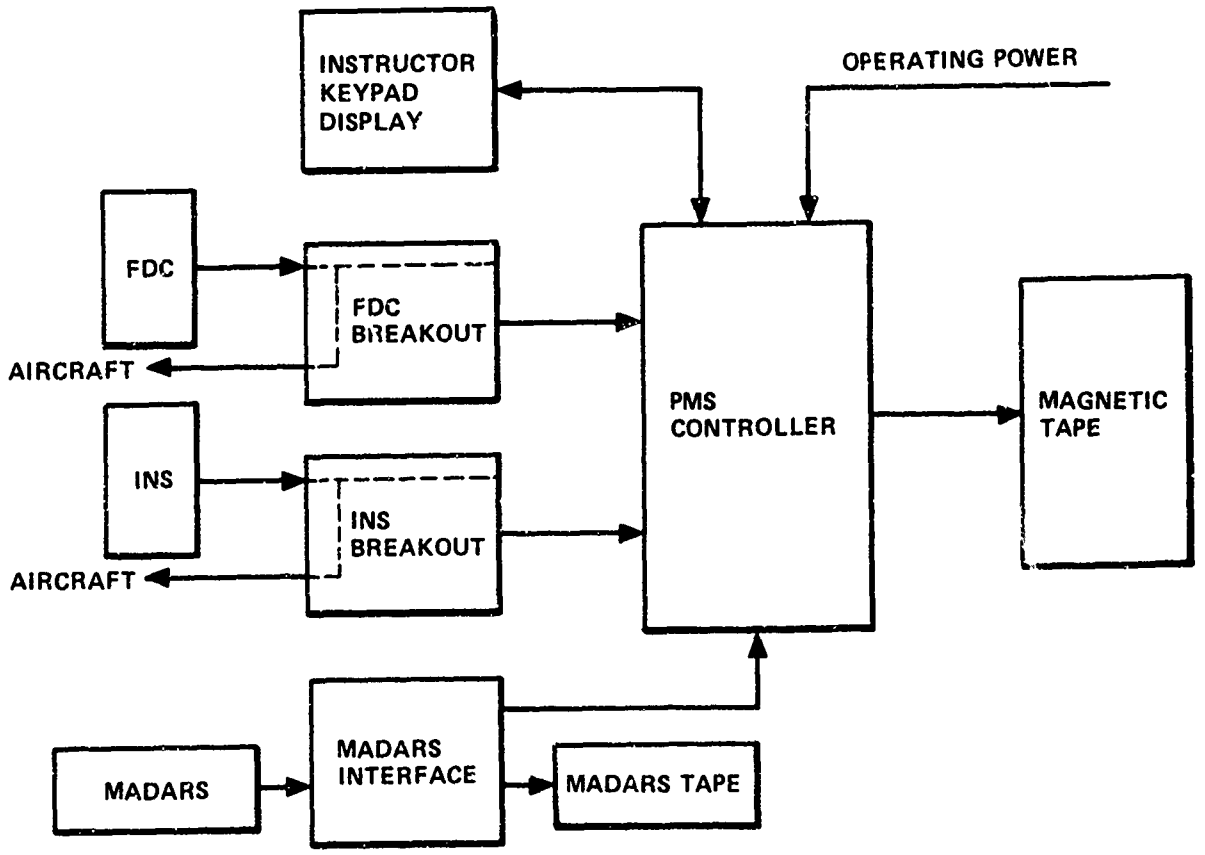

Figure 3. Airborne Recording System Hardware Block Diagram.

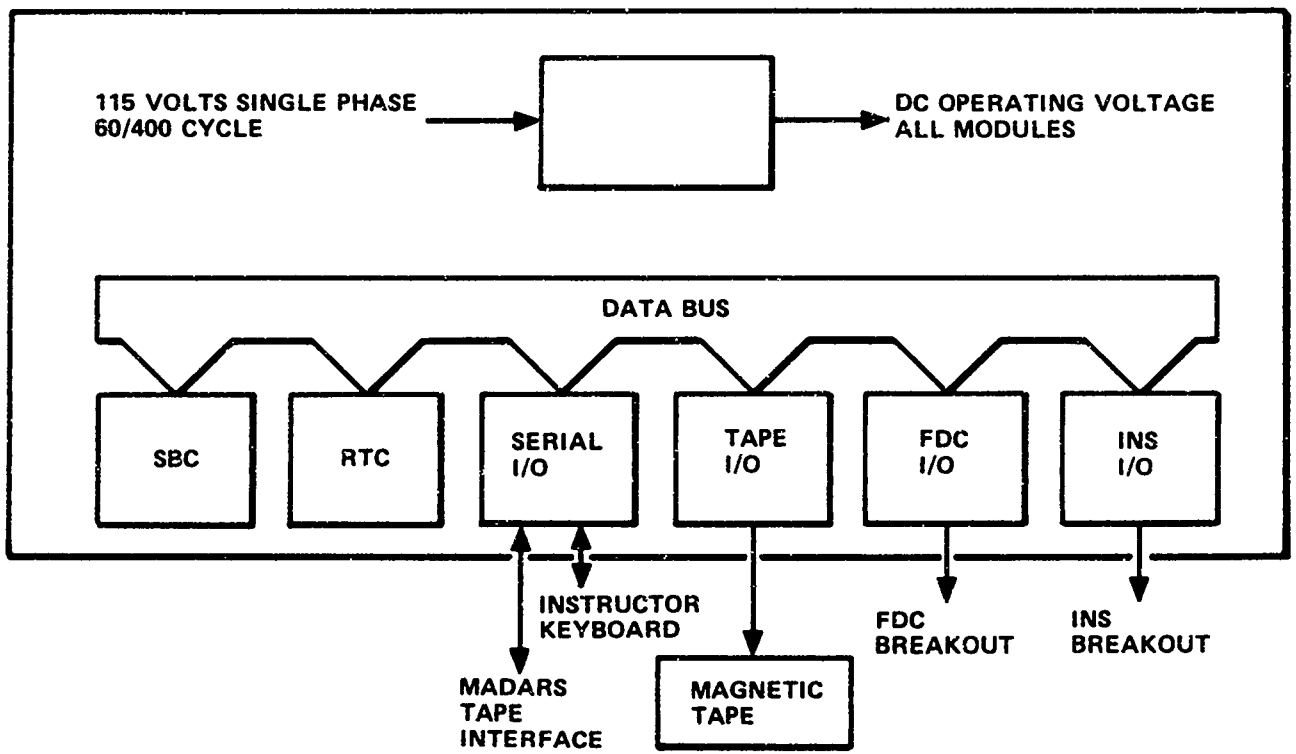

Figure 4. PMS Controller Block Diagram.

6. Real Time Clock (RTC). This unit provides the ability to time events to a high degree of accuracy, providing date and time information.

The above units all communicate over a high speed data bus and are physically located in the same card cage assembly, which, in turn, is located in the instrument case. A power supply to provide the required operating voltages for the components is also mounted in the case. The PMS controller will operate on aircraft power or ground power, 115 volts, 60 or 400 cycles, as required. During use of the system, the instrument case containing the controller will be placed in the luggage bay aft of the number two avionics bay. Cables will be run from the controller to the avionics bays for data acquisition.

The cartridge tape drive is used to provide a medium for storing the processed data and, additionally, as a method of transporting the data to the ground-based PMS system via the tape cartridge. The data from the PMS controller are stored on the magnetic tape as individually addressable blocks. The unit is mounted in the instrument case with the PMS controller and interfaces with the controller via the tape I/O unit. A cartridge tape unit was chosen for this application because of the general ruggedness of the unit, the small size, and the amount of storage. Additionally, the tape drive is easily interfaced to both the proposed airborne and the existing simulator PMS systems.

The instructor keypad and display is a small unit designed for handheld or tabletop use. It provides a means for the instructor to record information concerning the mission on the PMS tape. In this regard, it is similar to a CRT terminal in a computer system and, in fact, can be replaced by a CRT should the need arise. The unit consists of a keypad similar to the one used in the simulator PMS, and a small liquid crystal display with backlighting for night viewing. It communicates with the PMS controller via a serial data line and is stored in the instrument case when not in use.

The MADARS tape interface serves as the means by which the PMS controller obtains data from the MADARS system. Since the MADARS system communicates with its dedicated magnetic tape system using the MIL-1553B interface standard, this interface will serve as a "listen only" terminal in accordance with MIL-1553B. In this manner, any data sent to the MADARS magnetic tape unit will also be available to the PMS controller.

The MADARS tape interface will be installed in the avionics bay, near the MADARS tape unit. The cable to the tape unit will be removed and connected to the interface, and a short jumper cable will be connected from the interface unit to the tape unit. It is important to note that the MADARS-to-tape data path passes straight through the interface unit, and thus, the MADARS data recorded on tape are unaffected. There will be a cable from the interface unit to the PMS controller.

The FDC and INS breakout connections are similar in design, function and use; therefore, this description applies to both. The data required from the FDC and INS systems are not directly available at any location in the aircraft. A study of the C-5 configuration indicated that the easiest method of obtaining the requisite data was to tap into the lines at the actual FDC and INS. This is done by use of the "breakout" connector. Simply stated, the breakout connector is inserted between the equipment and its present connection to the aircraft. As in the MADARS tape interface, the connection from the FDC or INS to the remainder of the aircraft remains unchanged, but the data are available to the PMS controller via the parallel tap of the breakout. The connectors used would be the same as the type presently used in the Airline Transport Radio (ATR) mounts for the equipment. No signal conditioning is performed at this point since all signal processing and isolation are performed by the FDC and INS I/O interfaces in the PMS controller.

Aircraft Changes. The airborne PMS system is designed to have minimal impact on the operation of the aircraft. Additionally, the system requires no permanent physical or electrical changes to the aircraft. The system will operate on 115 volts AC, single phase, 60 or 400 cycles. Installation consists of placing the PMS controller in the small luggage compartment aft of avionics bay #2, installing the breakout connectors on the INS, FDC, and MADARS tape, routing the interconnecting cables and applying operating power. A more detailed description of equipment location and installation methods is provided below.

The controller unit will be placed in the luggage bay aft of the avionics bay, as shown in Figure 5, and will require no further attention after power is applied and the system is initialized. Data cables are run from the controller to the breakout connections. Access is available for cable routing from the luggage compartment to the two avionics bays without physical modification of the aircraft. The controller is physically secured by the use of tie-down straps in the compartment. As an alternative, the PMS controller can be located in the #2 avionics bay, in existing blank space on the equipment shelves. In the aircraft surveyed at Altus AFB, sufficient room existed for installation in either location, with no interference to normal aircraft operation.

The only physical modification required for the installation of the PMS was the installation of the breakout connectors in the FDC and INS equipment mounts. The breakout connection is essentially a line tap, which provides a method of obtaining data not otherwise available in the aircraft. The following description is generalized and applies equally to the FDC and the INS system.

Figure 6 shows a typical aircraft equipment mount and a representative piece of electronic gear. Of particular importance is the location of the connector area in the rear of the equipment mount. The breakout connector assembly is shown in Figure 7. The breakout connector is installed by

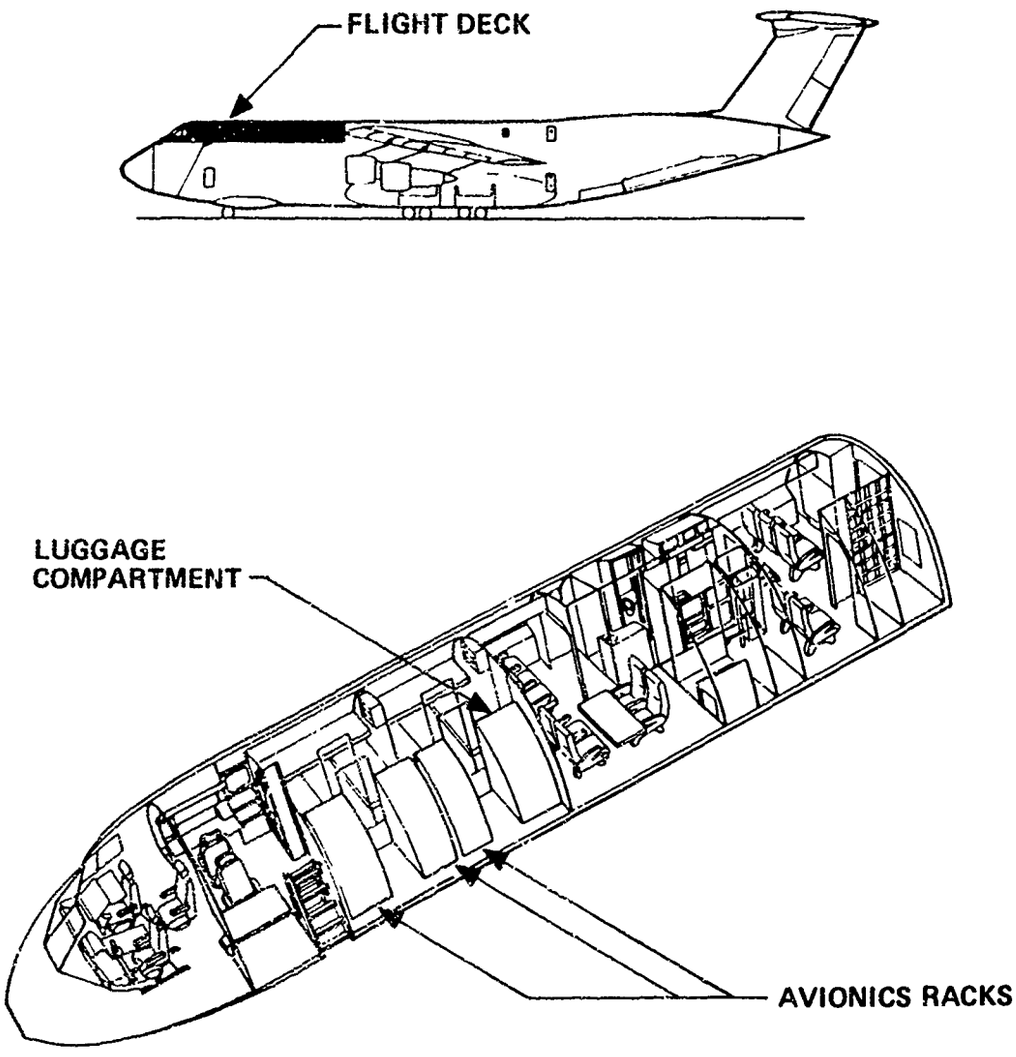

Figure 5. Equipment Areas.

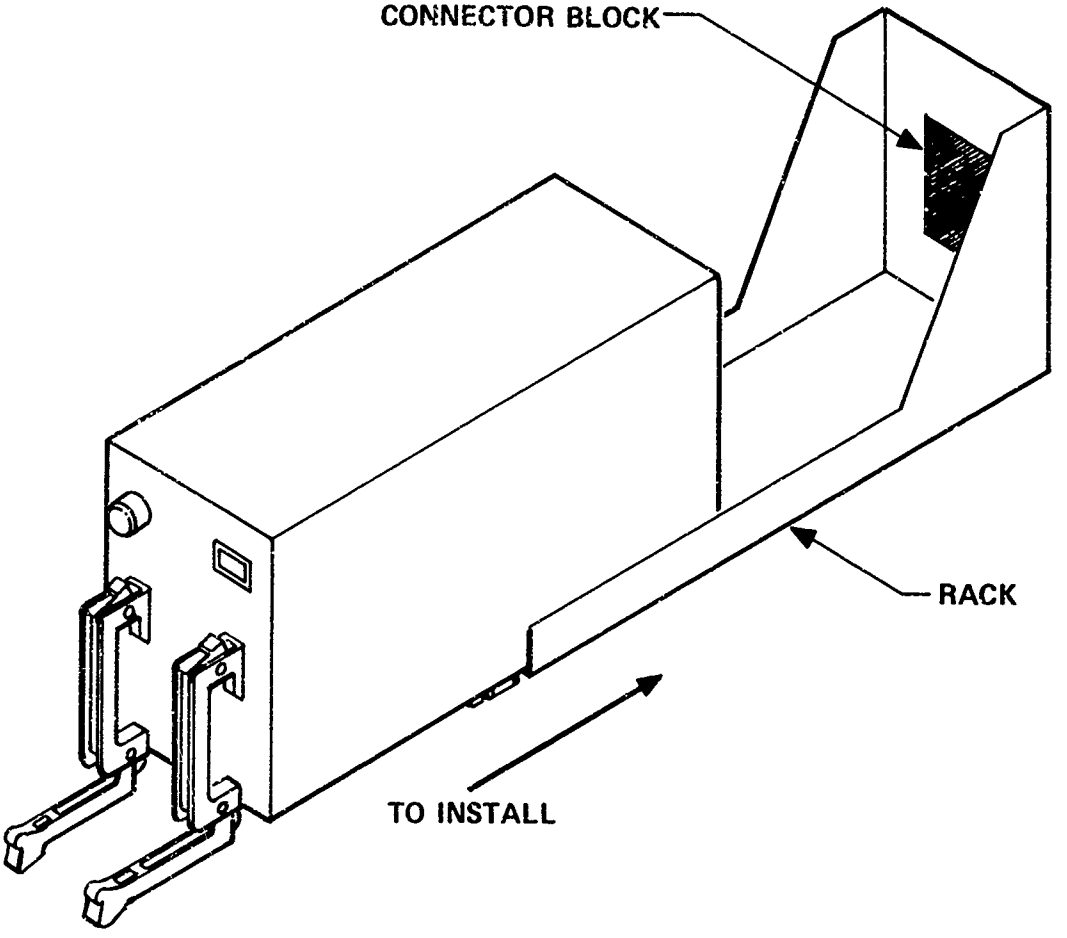

Figure 6. Typical Equipment and Rack Mount.

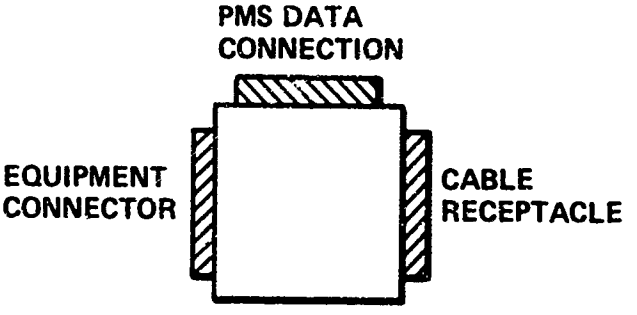

Figure 7. Breakout Box.

removing the original connector from the equipment mount, as shown in Figure 8. The new breakout connector is installed on the equipment mount in place of the original connector. The original connector is then attached to the breakout connector. The relationship of the components (equipment mount, breakout, and connector) are shown in the exploded view, Figure 9.

The same approach is utilized in interfacing to the MADARS tape unit. The connection between the MADARS and the MADARS tape is removed at the tape unit, and a breakout connection similar to the one utilized for the FDC or INS systems is inserted in the line. This serves to make data from the MADARS available to the PMS controller for analysis.

Software Requirements. The software for the airborne recording system will control the microprocessor in the acquisition and recording of airborne signal data. A block diagram of the required functions is shown in Figure 10. The following discussion describes the function of each block:

1. FDC, INS, MADARS Data Extraction. These three modules provide the interface with the C-5 systems. They will sample the data provided by the systems and extract those signals required by PMS.

2. Data Conversion. This module will take the raw signals from the data extraction routines and convert them into a standard digital format usable by the ground-based processing system.

3. Keyboard Input. This module will monitor the instructor keyboard entry device and interpret any entries made by the instructor.

4. Time Maintenance. This module will utilize a hardware real-time clock to maintain a mission clock.

5. Data Formatting. This module will format data packets for use by the ground-based system. Each packet will be made up of a data type identifier, mission time, and data (airplane extracted or instructor entered).

6. Buffer Management. This module will maintain a set of double buffers to prepare records of data for output to the recording device.

7. Data Output. This module writes the buffers of data to the recording device.

Ground-Based Design Specification

The ground-based portion of the C-5 airborne PMS will use the hardware and software of the simulator PMS. This hardware and software will be expanded and modified to accomplish the requirements of the airborne PMS.

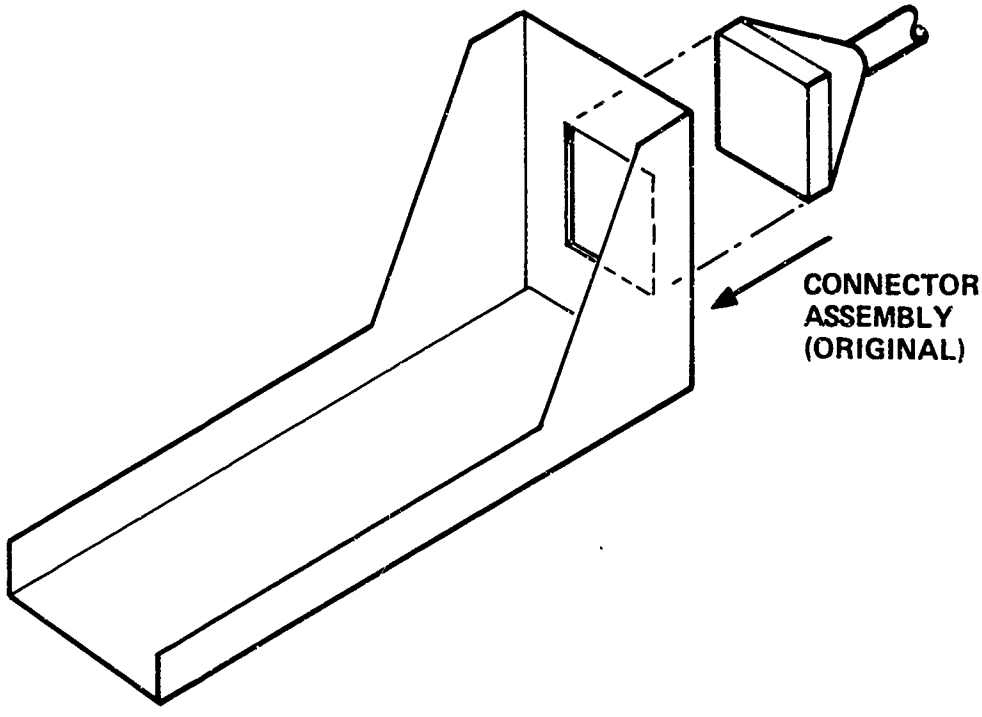

Figure 8. Equipment Mount Connector Location.

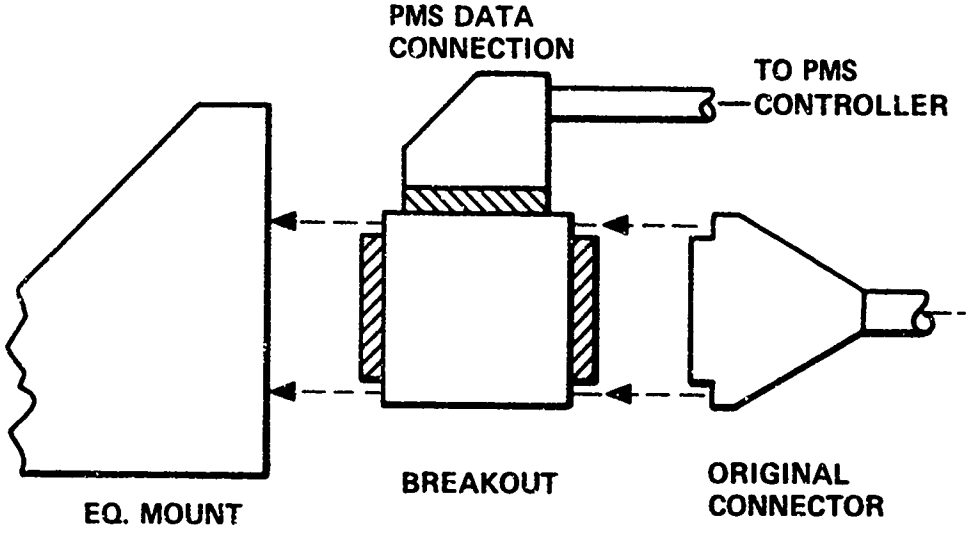

Figure 9. Exploded Installation Diagram.

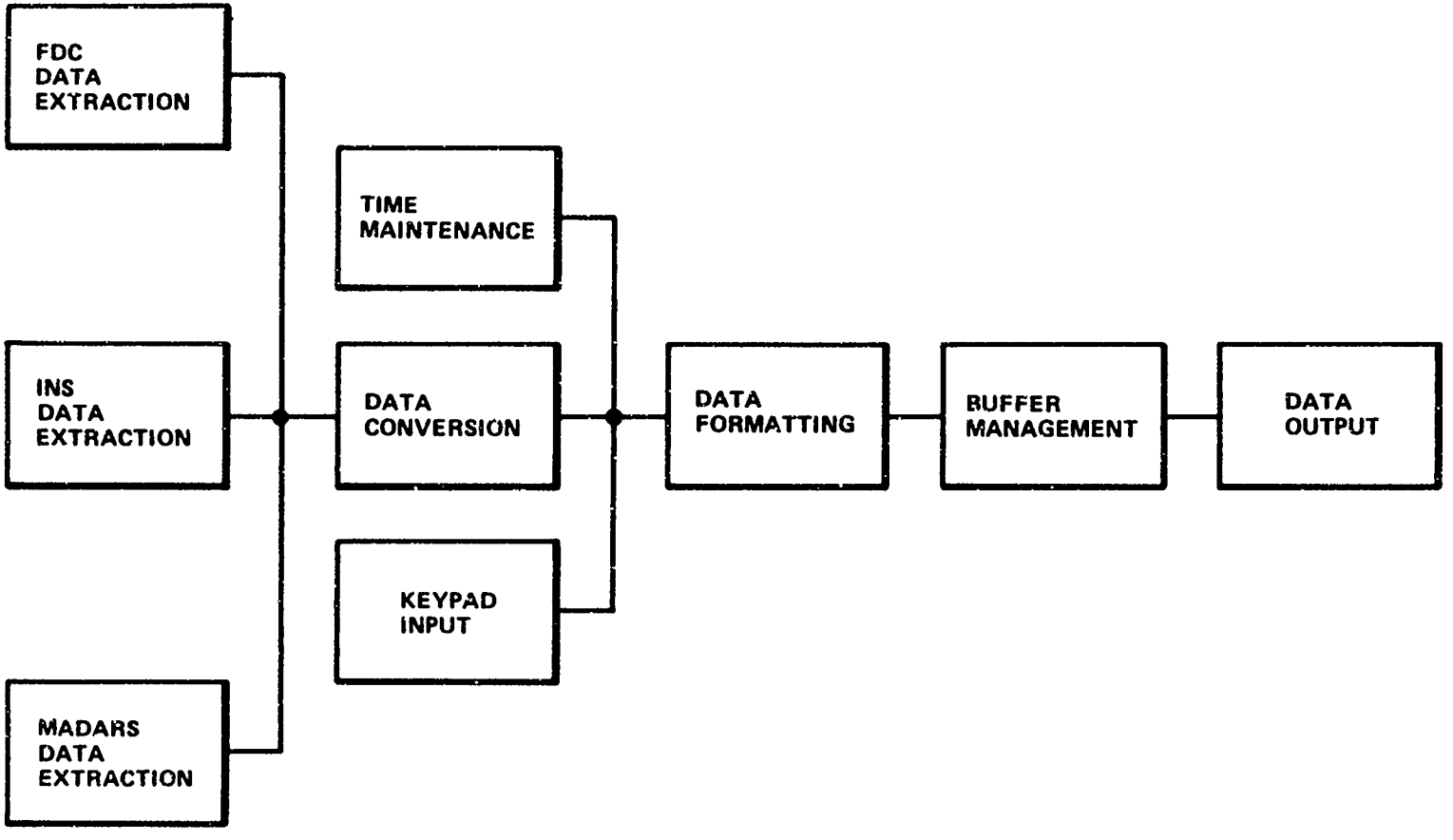

Figure 10. Airborne Recording System Software Functions.

Functional Requirements. The ground-based portion of the airborne PMS will process the recorded data from the airborne recording system and produce outputs equivalent to the simulator PMS. To accomplish this, it will perform the following functions:

1. Pre-process airborne recorded data (i) to extract data related to navigational profile monitoring, (ii) to mark start and end of navigational profiles, and (iii) to format input for the PMS monitor program

2. Perform performance measurement of airborne data

3. Provide performance data for statistical analysis

Hardware Requirements. The ground-based processing system will contain the hardware required to support the functional requirements. The study has shown that the simulator PMS possesses the computational power and peripherals to fulfill this need. The exception to this is a tape unit to interface with the airborne recording system. A block diagram of the current simulator PMS is shown in Figure 11. A block diagram of the ground-based system is shown in Figure 12. The shaded blocks of Figure 12 are components which must be added to the simulator PMS to accomplish ground-based processing.

The hardware divides into two systems connected by Multiprocessor Communications Adapter (MCA) Interfaces. The simulator Display Control Computer system will function as the interface to the airborne recording system. As such, it will be augmented by the attachment of a magnetic tape unit and associated controller. The sole function of this system is to read airborne data from the tape and pass these data to the System Control Computer via the MCA. The Display Control Terminal serves as the operator interface while the Disk Mass Storage provides programs and intermediate storage.

The System Control Computer hardware supports the processing of airborne performance data. It requires no additional hardware from that provided by the simulator PMS hardware suite. The System Control Computer provides the computational requirements of the system, which are less than those required for the simulator PMS. The System Control Terminal serves as the operator interface. The disk mass storage provides programs and data storage. The printer provides hardcopy of the various performance measure outputs.

The hardware components of the simulator PMS which will be utilized by the ground-based processing system are:

1. System Control Computer - Data General Corporation Eclipse S/130 general purpose mini-computer with 512 kilobytes (KB) of memory. The following additional circuit boards are a part of the computer system:

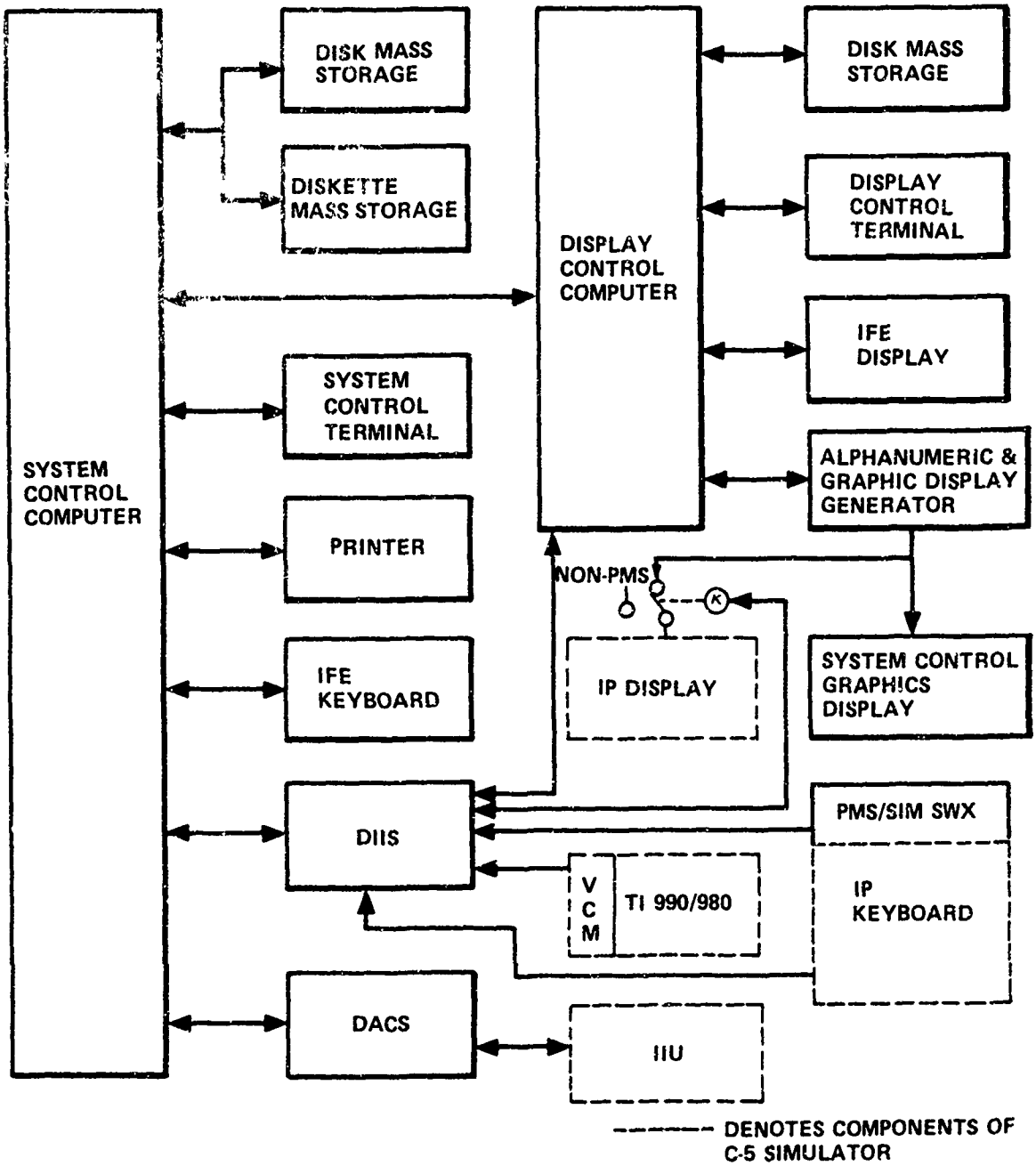

Figure 11. C-5 Simulator PMS Block Diagram.

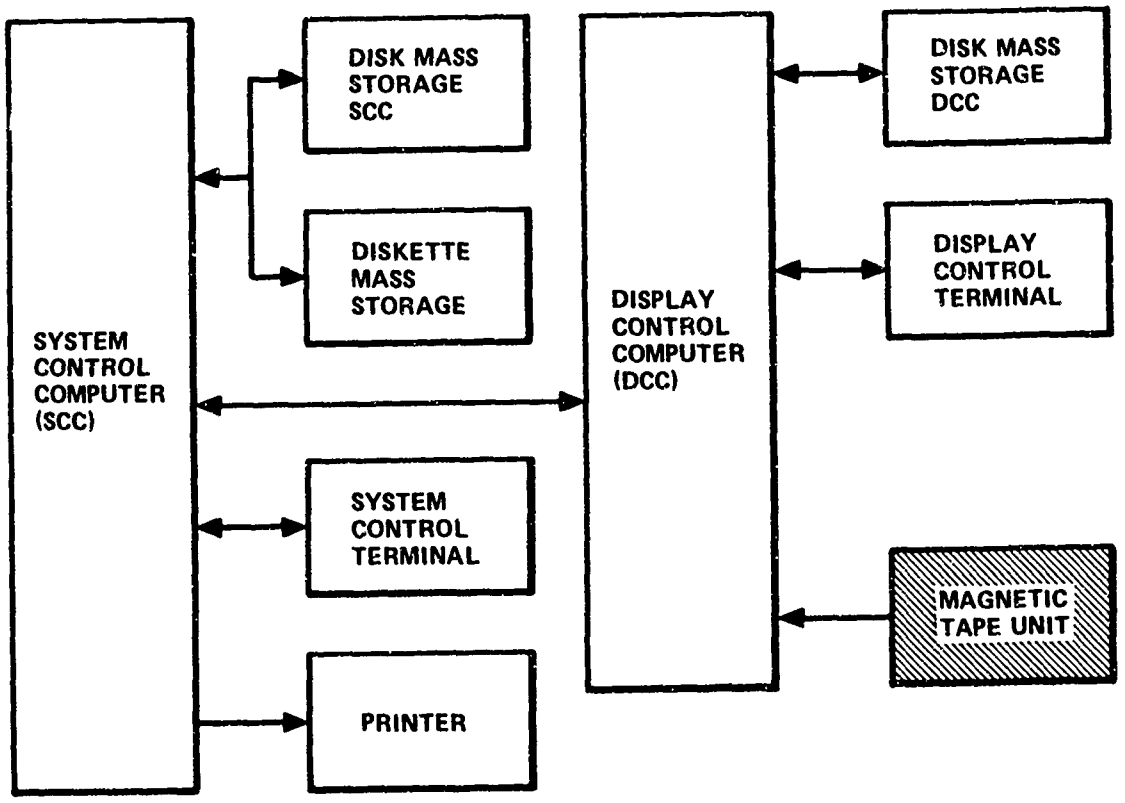

Figure 12. Ground Processing System Block Diagram.

a. Memory Allocation and Protection Unit (MAP)
b. Floating Point Instruction Set
c. Multiprocessor Communications Adapter (MCA)
d. Real-Time Clock
e. Disc Controller I/O Board
f. Four Channel I/O Board

2. Disk Mass Storage (SCC) - Data General Corporation Model 6045 disk unit containing 10 megabytes (MB) of storage

3. Diskette Mass Storage - Data General Corporation Model 6030 dual diskette unit, each with 308 kilobytes (KB) of storage

4. System Control Terminal - Micro Term Inc., Model MIME II CRT/keyboard terminal with a 12-inch diagonal CRT display, a 65-key keyboard, and a 12-key auxiliary numeric keypad.

5. Printer - Printronix Model P-600 printer

6. Display Control Computer - Data General Corporation Nova 4/S general purpose mini-computer with 64 kilobytes (KB) of memory. The following additional circuit boards are a part of the computer system:

   a. Multiprocessor Communications Adapter (MCA)
   b. Disc Controller I/O Board
   c. Four Channel I/O Board

7. Disk Mass Storage (DCC) - Data General Corporation Model 6045 disk unit containing 10 megabytes (MB) of storage

8. Display Control Terminal - Micro Term Inc., Model MIME II CRT/keyboard terminal with a 12-inch diagonal CRT display, a 65-key keyboard, and a 12-key auxiliary numeric keypad.

The hardware components which must be added to the simulator PMS to support ground-based processing are:

1. Magnetic Tape Controller - connected to the Display Control Computer, an off-the-shelf controller to interface the magnetic tape unit

2. Magnetic Tape Unit - A standard cartridge tape drive, similar to the tape drive in the airborne recording system

Software Requirements. The software for the ground-based processing system will use the simulator PMS software as a basis for software development. The majority of the main software modules are identical to the simulator PMS, especially in the later steps of processing. A block diagram of the main software functions of the simulator PMS is shown in Figure 13. A corresponding block diagram of the ground-based processing system software functions is shown in Figure 14. The following discussion describes the function of each block of Figure 14 and identifies the commonality with simulator PMS software.

1. Airborne Data Preprocessing. The airborne recorded data will be provided to the ground-based system on magnetic tape in a continuous stream from the start of the mission to the end. As such, the tape will contain a large amount of data not related to the segments being considered for performance measurement. This new module will execute as a stand-alone program. It will read the airborne data tape, identify the start and end of relevant navigational profiles, and extract the data associated with them. This extracted data will be placed in a disk file for use by the real-time PMS software.

2. Mission Generation. This program processes mission designer inputs and produces a monitor data base for use by the real-time performance measurement modules and a debrief data base for use by the Debrief program. No change is anticipated to this existing simulator PMS program.

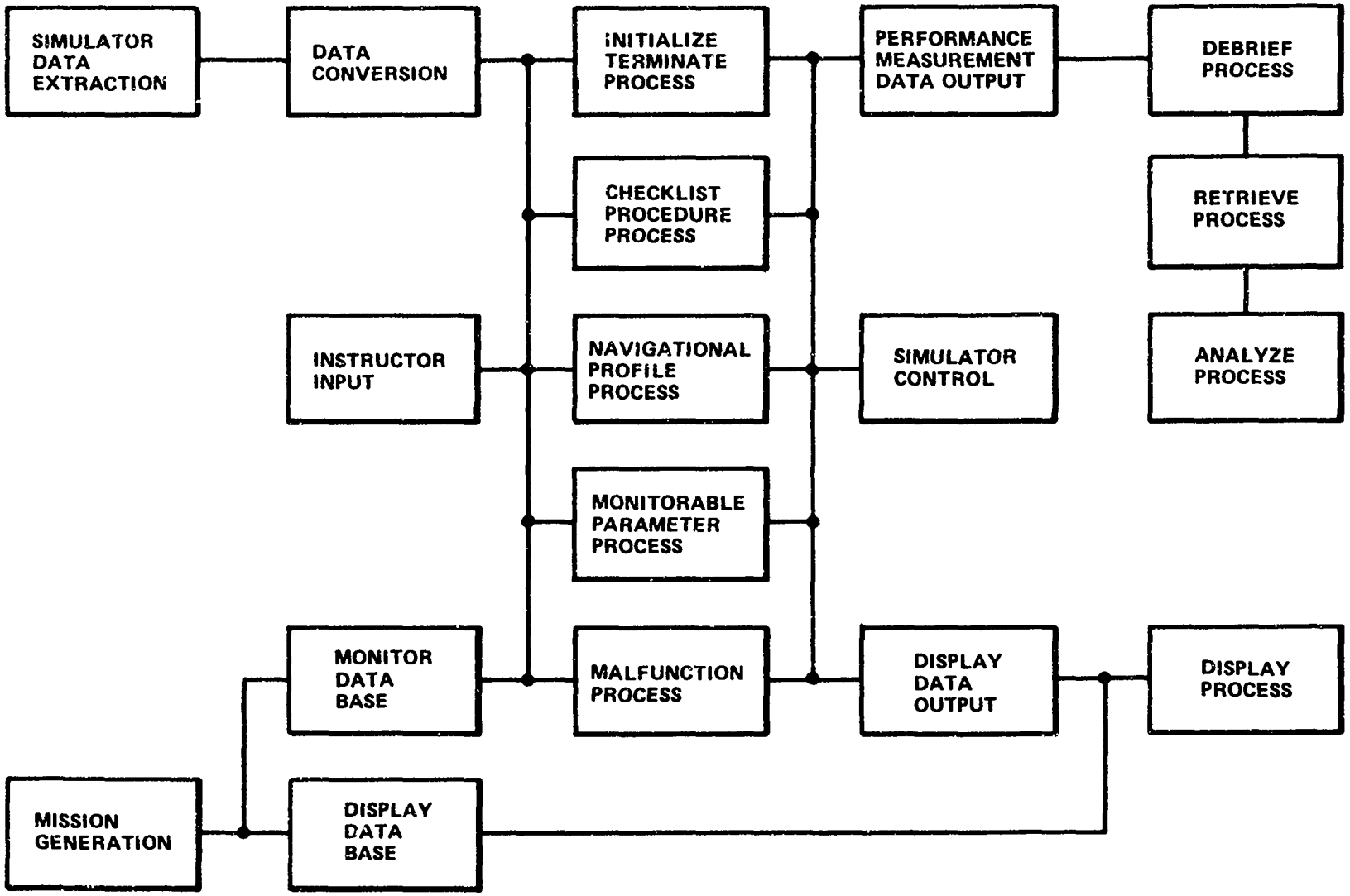

Figure 13. Simulator Performance Measurement System Software Functions.

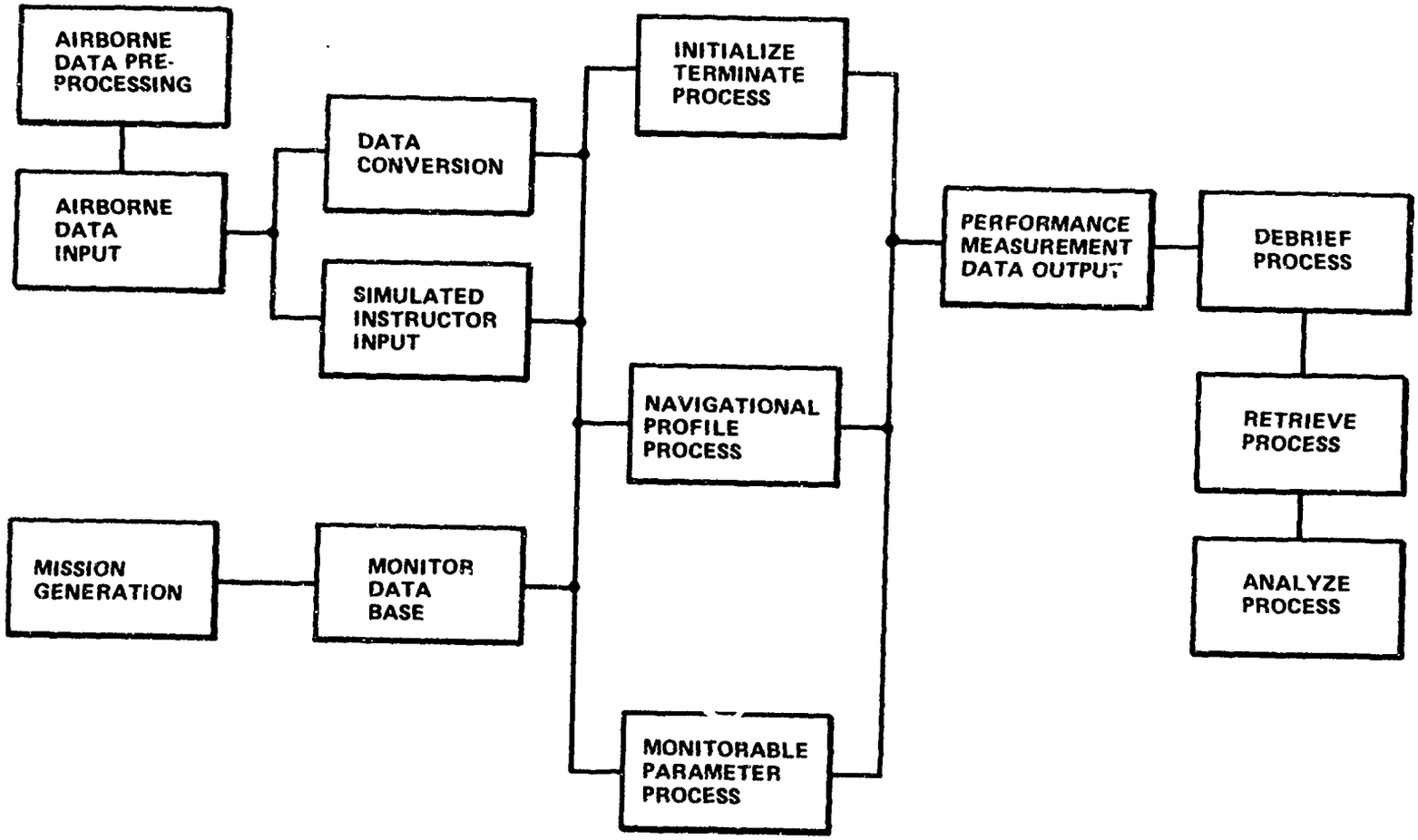

Figure 14. Ground-Based Processing System Software Functions.

3. Airborne Data Input. This will be a new module for the ground-based processing system. It replaces the simulator data extraction interface. It reads the disk file of preprocessed airborne data and inserts the data into the real-time monitor data base at the appropriate mission times for processing of performance measures.

4. Data Conversion. This module will provide the same function as the simulator data conversion module, but a new set of conversion algorithms must be developed. The data outputs of this module are used by the measurement modules.

5. Simulated Instructor Input. This new module will process data from the preprocessed airborne data file associated with mission control, including start/stop mission and start/stop navigational profile. This module will cause the real-time measurement software to operate in the manual mode.

6. Initialize/Terminate Process. This module is responsible for the setup, initialization and termination of the PMS system. It initializes all devices, reads the monitor data base and initializes the real-time modules. Although portions of the simulator PMS programs can be used, a major portion of this module will be new development.

7. Navigational Profile Process. This module is the major real-time process for the ground-based system. It will process the navigational profile related data from the airborne system and provide performance data for the post-mission processes. The simulator PMS navigational profile module will be used with some minor modifications. These relate to simulator control and to data that are not extracted from the airplane.

8. Monitorable Parameter Process. This module provides performance measurement data for monitorable parameters. The simulator PMS module will be used without change.

9. Performance Measurement Data Output. This portion of the ground-based system is identical to that for the simulator PMS. It produces a mission log file of performance measures for use by the post-mission programs.

10. Post-Mission Programs. The post-mission programs developed for the simulator PMS will be used without change by the ground-based system. These are the Debrief, Retrieve, and Analyze processes.

The ground-based processing system software obtained from the simulator PMS will contain references to interfaces not utilized, such as the display computer, the Data Acquisition and Control Subsystem (DACS), and the Data Interception and Interrogation Subsystem (DIIS). These references will be aborted or severed at the highest level possible.

In addition to the changes associated with PMS processing, diagnostics will be provided for the new equipment. This involves two areas. The first is an equipment diagnostic for the magnetic tape unit and controller. The second involves modification of the Confidence program to test only the equipment associated with the airborne PMS ground-based processing system.

System Design Summary

The system design described in this section provides an airborne performance measurement system which allows AFHRL personnel to collect data on aircrew performance during portions of their flight training related to navigational profile flying. The data collected from these missions are identical in format and type to data collected from the simulator PMS. This allows comparison of equivalent indices of performance measurement.

It was a design goal to configure a ground-based system which utilized the existing simulator PMS hardware and software. In the airplane, the design goal was to provide portability and to use off-the-shelf components where possible. In the area of portability, the PMS equipment should be installable in less than 1 day and should have no effect on aircraft reliability. The majority of the hardware components are off-the-shelf items. The exceptions to this are the FDC, INS, and MADARS interface components.

An estimate of the development cost of the airborne PMS is given in Appendix I. The off-the-shelf components were chosen and costed based on what was available as of the date of this report. An implementation of this design should include a product survey of current components.

SECTION V

SUMMARY

The study of the requirements for an airborne PMS for the C-5 was conducted in three phases. This section will summarize these phases and discuss the implications of the results on future aircraft systems in relation to performance measurement.

In Phase I of the effort, the requirements for an airborne PMS were explored. This included identification of R&D and instructor needs as well as uses for training course developers. Through definition of an airborne nominal mission similar to an equivalent simulator PMS mission, the functional capabilities of the airborne PMS were identified. This phase included an identification of the C-5 systems available to provide performance data.

The results of this phase showed that a mission could be identified for the airplane which was equivalent to a mission defined for the simulator. The major area of difference was that no malfunctions were identified for the airborne system; consequently, emergency checklist would not be monitored. Three airplane systems were identified as being capable of providing signal data to be used for performance measurement. These were the MADARS, the Flight Director Computer (FDC), and the Inertial Navigation System (INS). These three systems provided approximately 86 of the required 494 signals for airborne measurement.

In Phase II, various alternatives were considered for providing airborne performance measurement. It was determined that extensive changes to the C-5 airplane would be required in order to acquire the signals not provided by the systems identified in Phase I. This was undesirable from several points of view, including cost, safety, and usability. Therefore, an alternative nominal mission was defined which utilized the readily available signals. This was called the Navigational Profile nominal mission and measured only performance in flying navigational profiles and in maintaining parameters associated with navigational profiles.

The various possible approaches to recording and processing the performance data were investigated. At the end of Phase II, a design was chosen which extracted data from airplane systems using an onboard microcomputer and a recording medium. These recorded data are then processed on the ground by a modified version of the existing simulator PMS.

Phase III produced a system design for an airborne PMS system. This design basically calls for the construction of interfaces devices to the MADARS, FDC, and INS. These devices are sampled by an onboard microcomputer

and the data is written to a magnetic tape unit. This onboard airborne recording system is operational from the start of a training mission until its completion.

The design also calls for the processing of this recorded data tape by a ground-based system. This system would be built around the current simulator PMS system, with the addition of a magnetic tape unit. The majority of the simulator PMS software would be used, with new software added to read and process the data from the tape as opposed to extracting data from the simulator. Programs related to debriefing reports, data retrieval, and data analysis would be identical to the simulator PMS.

The major drawback to producing an airborne PMS system for the C-5 proved to be in the area of data extraction. The C-5 wiring is organized in a point-to-point arrangement. This means that there is no central place where all the data are available. To extract the data required for full performance measurement would entail constructing many extraction devices and considerable airplane modification and additional wiring. This is prohibitive. For an airborne PMS to be completely useful, it must have access to large amounts of data from many sources. This requires a data passing interface organized on a data bus. The extraction hardware for the PMS would then interface to this bus and acquire whatever data it required.

With a system where the PMS had access to the full range of data, it would be possible to design an airborne PMS system which would be equivalent to the current simulator PMS. This would provide the data needed to assess such things as transference of training from the simulator to the airplane, to provide instructors with performance data, and to evaluate the effectiveness of course makeup. It would be constructive if future aircraft designs took into consideration the requirements for the measurement of crew performance and incorporated methods for easy extraction of all crew actions.

REFERENCE

Swink, Jay R., Butler, Edward A., Lankford, Harry E., Miller, Ralph M., and Watkins, Hal, "Definition of Requirements for a Performance Measurement System for C-5 Aircrew Members", AFHRL-TR-78-54, October 1978.

GLOSSARY

This glossary defines terms and acronyms peculiar to aircraft systems and PMS which may be unfamiliar to the reader. These terms and acronyms are found throughout the body of the report.

A/I	Anti-Ice
AC	Alternating Current
ADF	Automatic Direction Finding
AFHRL	Air Force Human Resources Laboratory
ALDCS	Active Lift Distribution Control Subsystem
APU	Auxiliary Power Unit
ATR	Airline Transport Ratio
CDI	Course Deviation Indicator
CFI	Cockpit Familiarization Trainer
CPT	Cockpit Procedural Trainer
CSD	Constant Speed Drive
DACS	Data Acquisition and Control Subsystem
DC	Direct Current
DCC	Display Control Computer
DIIS	Data Interception and Interrogation Subsystem
DME	Distance Measuring Equipment
EGT	Exhaust Gas Temperature
EPR	Engine Pressure Ratio
FDC	Flight Director Computer
FE	Flight Engineer
GSI	GlideSlope deviation Indicator

IFE	Instructor Flight Engineer
INS	Inertial Navigation System
IP	Instructor Pilot
KB	KiloByte - 1024 bytes
MAC	Military Airlift Command
MADARS	MAlfunction Detection, Analysis and Recording System
MB	MegaByte - 1024 KB
MCA	Multiprocessor Communications Adapter
MDR	Maintenance Data Recorder
N1	Engine Fan RPM
N2	Engine High Pressure Compressor RPM
P	Pilot; Pilot/Copilot
PAR	Proficiency Assessment Records
PMS	Performance Measurement System
RDF	Retrieved Data File
RPM	Revolutions Per Minute
RTC	Real-Time Clock
SBC	Single Board Computer
SCC	System Control Computer
TACAN	TACtical Air Navigation
TIT	Turbine Inlet Temperature
VOR	Visual Omni Range

APPENDIX A

AIRBORNE NOMINAL MISSION OVERVIEW

MISSION: ?
CREW: BOTH

SESSION 1:

SET-UP:
AIRCRAFT CONFIGURATION:

OPERATING-WEIGHT	??????	LBS	
RAMP-FUEL	??????	LBS	
CARGO/PAX	?????	LBS	
CENTER-OF-GRAVITY	??	%	
FUEL-MANAGEMENT	???		

TOLD CARD WORKSHEET:

EPR-TRT-STAT	?.??		
EPR-TRT-IF	?.??		
EPR-T/O-STAT	?.??		
EPR-T/O-IF	?.??		
TAKE-OFF-STAB-TRIM	?.??		
V-ROT	???	KNOTS	
V-MCO	???	KNOTS	
V-MFR	???	KNOTS	
H-MFR	????	FEET	
V-TLS	???	KNOTS	
V-GO	???	KNOTS	
XWIND-T/O-MAX	?.?	DEG	
XWIND-T/O-MIN	?.?	DEG	
XWIND-SETTING-T/O	?.?	DEG	
XWIND-SETTING-LAND	?.?	DEG	
FLT-ALT-MAX	?????	FEET	
FLT-ALT-MIN	?????	FEET	

DEPARTURE INITIALIZATION:

INITIAL-LATITUDE	34 38.64 N		; ALTUS 35
INITIAL-LONGITUDE	99 16.52 W		
FIELD	ALTUS		
RUNWAY-IDENTIFIER	35		
RUNWAY-HEADING	351	DEG	
FIELD-ELEVATION	1378	FEET	
ALTIMETER-SETTING	??.??	IN HG	
RUNWAY-TEMPERATURE	?	DEG C	
CRUISE-TEMPERATURE-DEVIATION	?	DEG C	
WIND-DIRECTION	?	DEG	
WIND-VELOCITY	?	KNOTS	
WIND-GUSTS	??????		

```
MONITORABLE PARAMETERS:
     STANDARD-LIST

BEFORE INTERIOR CHECK:
     MONITOR "BEFORE INTERIOR" CHECKLIST

INTERIOR CHECK:
     MONITOR "INTERIOR (1-15)" CHECKLIST
     MONITOR "INTERIOR (16-30)" CHECKLIST
     MONITOR "INTERIOR (31-37)" CHECKLIST
     MONITOR "INTERIOR (38-60)" CHECKLIST
     MONITOR "INTERIOR (61-66)" CHECKLIST
     MONITOR "INTERIOR (67-73)" CHECKLIST
     MONITOR "INTERIOR (74-80)" CHECKLIST
     MONITOR "INTERIOR (81-105)" CHECKLIST

BEFORE STARTING ENGINES:
     MONITOR "BEFORE STARTING ENGINES" CHECKLIST
     MONITOR "STANDARD FUEL MANAGEMENT" PROCEDURE

STARTING ENGINES:
     MONITOR "STARTING ENGINES" CHECKLIST

BEFORE TAXI:
     MONITOR "BEFORE TAXI" CHECKLIST

TAXI:
     MONITOR "TAXI" CHECKLIST

BEFORE TAKE OFF:
     MONITOR "BEFORE TAKE OFF" CHECKLIST

LINEUP:
     MONITOR "LINEUP" CHECKLIST

TAKE OFF:
     MONITOR "TAKEOFF THROTTLE SETTING" PROCEDURE

AFTER TAKE OFF CLIMB:
     MONITOR "HOBART FIVE DEPT 35" DEPARTURE PROFILE

APPROACH:
     MONITOR "APPROACH" CHECKLIST
     MONITOR "ALTUS LOW ILS RWY 35" APPROACH PROFILE

BEFORE LANDING:
     MONITOR "BEFORE LANDING" CHECKLIST
     MONITOR "ALTUS ILS RWY 35" ILS-FINAL PROFILE
     MONITOR "ALTUS TACAN 17" APPROACH PROFILE
     MONITOR "BEFORE LANDING" CHECKLIST
     MONITOR "ALTUS VOR DME RWY 35" APPROACH PROFILE
     MONITOR "BEFORE LANDING" CHECKLIST
```

SESSION 2:

MONITORABLE PARAMETERS:
STANDARD-LIST

BEFORE LANDING:
MONITOR "STANDARD FUEL MANAGEMENT" PROCEDURE
MONITOR "HOBART FIVE DEPT 35" DEPARTURE PROFILE
MONITOR "ALTUS LOW ILS RWY 35" APPROACH PROFILE
MONITOR "BEFORE LANDING" CHECKLIST
MONITOR "ALTUS ILS RWY 35" ILS-FINAL PROFILE
MONITOR "ALTUS TACAN 17" APPROACH PROFILE
MONITOR "BEFORE LANDING" CHECKLIST
MONITOR "ALTUS VOR DME RWY 35" APPROACH PROFILE
MONITOR "BEFORE LANDING" CHECKLIST
MONITOR "LANDING" PROCEDURE

AFTER LANDING:
MONITOR "AFTER LANDING" CHECKLIST

ENGINE SHUTDOWN:
MONITOR "ENGINE SHUTDOWN" CHECKLIST

BEFORE LEAVING AIRCRAFT:
MONITOR "BEFORE LEAVING AIRPLANE" CHECKLIST

CREW MEMBER ASSESSMENT:

SESSION 1; PILOT:

CHECK-PROC	MIN % 70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN % 70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN % 70	CRIT FACT 0.95	WGT 0.9

SESSION 1; COPILOT:

CHECK-PROC	MIN % 70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN % 70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN % 70	CRIT FACT 0.95	WGT 0.9

SESSION 1; FLIGHT ENGINEER:

CHECK-PROC	MIN % 70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN % 70	CRIT FACT 0.95	WGT 0.7

SESSION 1; CREW COORDINATION:

CHECK-PROC	MIN % 70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN % 70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN % 70	CRIT FACT 0.95	WGT 0.7

SESSION 2; PILOT:

CHECK-PROC	MIN %	70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN %	70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN %	70	CRIT FACT 0.95	WGT 0.9

SESSION 2; COPILOT:

CHECK-PROC	MIN %	70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN %	70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN %	70	CRIT FACT 0.95	WGT 0.9

SESSION 2; FLIGHT ENGINEER:

CHECK-PROC	MIN %	70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN %	70	CRIT FACT 0.95	WGT 0.7

SESSION 2; CREW COORDINATION:

CHECK-PROC	MIN %	70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN %	70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN %	70	CRIT FACT 0.95	WGT 0.7

SESSION ASSESSMENT:

SESSION 1:

PILOT	MIN %	70	CRIT FACT 0.95	WGT 2.0
COPILOT	MIN %	70	CRIT FACT 0.95	WGT 1.0
FLT ENGR	MIN %	70	CRIT FACT 0.95	WGT 2.0
CREW COORD	MIN %	70	CRIT FACT 0.95	WGT 1.5

SESSION 2:

PILOT	MIN %	70	CRIT FACT 0.95	WGT 2.0
COPILOT	MIN %	70	CRIT FACT 0.95	WGT 1.0
FLT ENGR	MIN %	70	CRIT FACT 0.95	WGT 2.0
CREW COORD	MIN %	70	CRIT FACT 0.95	WGT 1.5

MISSION ASSESSMENT:

SESSION 1	MIN %	70	CRIT FACT 0.95	WGT 1.0
SESSION 2	MIN %	70	CRIT FACT 0.95	WGT 1.0

APPENDIX B

SIMULATOR NOMINAL MISSION OVERVIEW

MISSION: ?
CREW: BOTH

SESSION 1:

SET-UP:
AIRCRAFT CONFIGURATION:

OPERATING-WEIGHT	359000	LBS
RAMP-FUEL	175000	LBS
CARGO/PAX	0	LBS
CENTER-OF-GRAVITY	39	%
FUEL-MANAGEMENT	ALTERNATE	

TOLD CARD WORKSHEET:

EPR-TRT-STAT	5.17	
EPR-TRT-IF	5.04	
EPR-T/O-STAT	4.77	
EPR-T/O-IF	4.64	
TAKE-OFF-STAB-TRIM	-.90	
V-ROT	121	KNOTS
V-MCO	131	KNOTS
V-MFR	156	KNOTS
H-MFR	2378	FEET
V-TLS	175	KNOTS
V-GO	121	KNOTS
XWIND-T/O-MAX	-3.0	DEG
XWIND-T/O-MIN	3.0	DEG
XWIND-SETTING-T/O	0.0	DEG
XWIND-SETTING-LAND	0.0	DEG
FLT-ALT-MAX	5000	FEET
FLT-ALT-MIN	2378	FEET

DEPARTURE INITIALIZATION:

INITIAL-LATITUDE	34 38.64 N		; ALTUS 35
INITIAL-LONGITUDE	99 16.52 W		
FIELD	ALTUS		
RUNWAY-IDENTIFIER	35		
RUNWAY-HEADING	351	DEG	
FIELD-ELEVATION	1378	FEET	
ALTIMETER-SETTING	29.79	IN HG	
RUNWAY-TEMPERATURE	15	DEG C	
CRUISE-TEMPERATURE-DEVIATION	0	DEG C	
WIND-DIRECTION	180	DEG	
WIND-VELOCITY	5	KNOTS	
WIND-GUSTS	STEADY		

MONITORABLE PARAMETERS:
STANDARD-LIST

```
BEFORE INTERIOR CHECK:
     MONITOR "BEFORE INTERIOR" CHECKLIST

INTERIOR CHECK:
     MONITOR "INTERIOR (1-15)" CHECKLIST
     MONITOR "INTERIOR (16-30)" CHECKLIST
     MONITOR "INTERIOR (31-37)" CHECKLIST
     MONITOR "INTERIOR (38-60)" CHECKLIST
     MONITOR "INTERIOR (61-66)" CHECKLIST
     MONITOR "INTERIOR (67-73)" CHECKLIST
     MONITOR "INTERIOR (74-80)" CHECKLIST
     MONITOR "INTERIOR (81-105)" CHECKLIST

BEFORE STARTING ENGINES:
     MONITOR "BEFORE STARTING ENGINES" CHECKLIST
     MONITOR "STANDARD FUEL MANAGEMENT" PROCEDURE

STARTING ENGINES:
     MONITOR "STARTING ENGINES" CHECKLIST

BEFORE TAXI:
     MONITOR "BEFORE TAXI" CHECKLIST

TAXI:
     MONITOR "TAXI" CHECKLIST

BEFORE TAKE OFF:
     MONITOR "BEFORE TAKE OFF" CHECKLIST

LINEUP:
     MONITOR "LINEUP" CHECKLIST
     WHEN P-IAS GE 121 THEN
     BEGIN
     ENTER MALFUNCTION 350
     ENTER MALFUNCTION 010
     END
     MALFUNCTION TEXT: "WHEN AIRSPEED EXCEEDS 121 KCAS"
     MALFUNCTION TEXT: "     ENTER MALFUNCTION 350"
     MALFUNCTION TEXT: "     ENTER MALFUNCTION 010"

TAKE OFF:
     MONITOR "TAKEOFF THROTTLE SETTING" PROCEDURE
     MONITOR "PRECAUTIONARY ENG "1 SHUTDOWN" CHECKLIST
     MONITOR "FUEL JETTISON" CHECKLIST

AFTER TAKE OFF CLIMB:
     MONITOR "HOBART FIVE DEPT 35" DEPARTURE PROFILE

APPROACH:
     MONITOR "APPROACH" CHECKLIST
     MONITOR "ALTUS LOW ILS RWY 35" APPROACH PROFILE
```

```
BEFORE LANDING:
     MONITOR "BEFORE LANDING" CHECKLIST
     MONITOR "ALTUS ILS RWY 35" ILS-FINAL PROFILE
     MONITOR "ALTUS TACAN 17" APPROACH PROFILE
     MONITOR "BEFORE LANDING" CHECKLIST
     MONITOR "ALTUS VOR DME RWY 35" APPROACH PROFILE
     MONITOR "BEFORE LANDING" CHECKLIST

     SESSION 2:

MONITORABLE PARAMETERS:
     STANDARD-LIST

BEFORE LANDING:
     MONITOR "STANDARD FUEL MANAGEMENT" PROCEDURE
     MONITOR "HOBART FIVE DEPT 35" DEPARTURE PROFILE
     MONITOR "ALTUS LOW ILS RWY 35" APPROACH PROFILE
     MONITOR "BEFORE LANDING" CHECKLIST
     MONITOR "ALTUS ILS RWY 35" ILS-FINAL PROFILE
     MONITOR "ALTUS TACAN 17" APPROACH PROFILE
     MONITOR "BEFORE LANDING" CHECKLIST
     MONITOR "ALTUS VOR DME RWY 35"  APPROACH PROFILE
     MONITOR "BEFORE LANDING" CHECKLIST
     MONITOR "LANDING" PROCEDURE

AFTER LANDING:
     MONITOR "AFTER LANDING" CHECKLIST

ENGINE SHUTDOWN:
     MONITOR "ENGINE SHUTDOWN" CHECKLIST

BEFORE LEAVING AIRCRAFT:
     MONITOR "BEFORE LEAVING AIRPLANE" CHECKLIST

CREW MEMBER ASSESSMENT:

SESSION 1; PILOT:
CHECK-PROC          MIN %  70    CRIT FACT 0.95  WGT 1.0
NAV PROFL           MIN %  70    CRIT FACT 0.95  WGT 1.0
PARAMETER           MIN %  70    CRIT FACT 0.95  WGT 0.9

SESSION 1; COPILOT:
CHECK-PROC          MIN %  70    CRIT FACT 0.95  WGT 1.0
NAV PROFL           MIN %  70    CRIT FACT 0.95  WGT 1.0
PARAMETER           MIN %  70    CRIT FACT 0.95  WGT 0.9

SESSION 1; FLIGHT ENGINEER:
CHECK-PROC          MIN %  70    CRIT FACT 0.95  WGT 1.0
PARAMETER           MIN %  70    CRIT FACT 0.95  WGT 0.7
```

SESSION 1; CREW COORDINATION:

CHECK-PROC	MIN %	70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN %	70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN %	70	CRIT FACT 0.95	WGT 0.7

SESSION 2; PILOT:

CHECK-PROC	MIN %	70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN %	70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN %	70	CRIT FACT 0.95	WGT 0.9

SESSION 2; COPILOT:

CHECK-PROC	MIN %	70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN %	70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN %	70	CRIT FACT 0.95	WGT 0.9

SESSION 2; FLIGHT ENGINEER:

CHECK-PROC	MIN %	70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN %	70	CRIT FACT 0.95	WGT 0.7

SESSION 2; CREW COORDINATION:

CHECK-PROC	MIN %	70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN %	70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN %	70	CRIT FACT 0.95	WGT 0.7

SESSION ASSESSMENT:

SESSION 1:

PILOT	MIN %	70	CRIT FACT 0.95	WGT 2.0
COPILOT	MIN %	70	CRIT FACT 0.95	WGT 1.0
FLT ENGR	MIN %	70	CRIT FACT 0.95	WGT 2.0
CREW COORD	MIN %	70	CRIT FACT 0.95	WGT 1.5

SESSION 2:

PILOT	MIN %	70	CRIT FACT 0.95	WGT 2.0
COPILOT	MIN %	70	CRIT FACT 0.95	WGT 1.0
FLT ENGR	MIN %	70	CRIT FACT 0.95	WGT 2.0
CREW COORD	MIN %	70	CRIT FACT 0.95	WGT 1.5

MISSION ASSESSMENT:

SESSION 1	MIN %	70	CRIT FACT 0.95	WGT 1.0
SESSION 2	MIN %	70	CRIT FACT 0.95	WGT 1.0

APPENDIX C

AIRBORNE NOMINAL (NAVIGATIONAL PROFILE) MISSION OVERVIEW

MISSION: ?
CREW: BOTH

SESSION 1:

SET-UP:
AIRCRAFT CONFIGURATION:

OPERATING-WEIGHT	??????	LBS	
RAMP-FUEL	??????	LBS	
CARGO/PAX	?????	LBS	
CENTER-OF-GRAVITY	??	%	
FUEL-MANAGEMENT	???		

TOLD CARD WORKSHEET:

EPR-TRT-STAT	?.??		
EPR-TRT-IF	?.??		
EPR-T/O-STAT	?.??		
EPR-T/O-IF	?.??		
TAKE-OFF-STAB-TRIM	?.??		
V-ROT	???	KNOTS	
V-MCO	???	KNOTS	
V-MFR	???	KNOTS	
H-MFR	????	FEET	
V-TLS	???	KNOTS	
V-GO	???	KNOTS	
XWIND-T/O-MAX	?.?	DEG	
XWIND-T/O-MIN	?.?	DEG	
XWIND-SETTING-T/O	?.?	DEG	
XWIND-SETTING-LAND	?.?	DEG	
FLT-ALT-MAX	?????	FEET	
FLT-ALT-MIN	?????	FEET	

DEPARTURE INITIALIZATION:

INITIAL-LATITUDE	34 38.64 N		; ALTUS 35
INITIAL-LONGITUDE	99 16.52 W		
FIELD	ALTUS		
RUNWAY-IDENTIFIER	35		
RUNWAY-HEADING	351	DEG	
FIELD-ELEVATION	1378	FEET	
ALTIMETER-SETTING	??.??	IN HG	
RUNWAY-TEMPERATURE	?	DEG C	
CRUISE-TEMPERATURE-DEVIATION	?	DEG C	
WIND-DIRECTION	?	DEG	
WIND-VELOCITY	?	KNOTS	
WIND-GUSTS	??????		

```
MONITORABLE PARAMETERS:
     AIRSPEED
     ANGLE-OF-ATTACK
     FLAP-POS-IND
     GROUND-SPEED
     L-LANDING-LIGHT-SW
     LANDING-GEAR-LEVER
     NLG-STEERING-IND
     NOSE-LANDING-LIGHT-SW
     PITCH
     R-LANDING-LIGHT-SW
     ROLL
     VERT-ACCELEROMETER
     VERTICAL-SPEED
     YAW


AFTER TAKE OFF CLIMB:
     MONITOR "HOBART FIVE DEPT 35" DEPARTURE PROFILE

APPROACH:
     MONITOR "ALTUS LOW ILS RWY 35" APPROACH PROFILE

BEFORE LANDING:
     MONITOR "ALTUS ILS RWY 35" ILS-FINAL PROFILE
     MONITOR "ALTUS TACAN 17" APPROACH PROFILE
     MONITOR "ALTUS VOR DME RWY 35" APPROACH PROFILE




SESSION 2:

MONITORABLE PARAMETERS:
     AIRSPEED
     ANGLE-OF-ATTACK
     FLAP-POS-IND
     GROUND-SPEED
     L-LANDING-LIGHT-SW
     LANDING-GEAR-LEVER
     NLG-STEERING-IND
     NOSE-LANDING-LIGHT-SW
     PITCH
     R-LANDING-LIGHT-SW
     ROLL
     VERT-ACCELEROMETER
     VERTICAL-SPEED
     YAW

BEFORE LANDING:
     MONITOR "HOBART FIVE DEPT 35" DEPARTURE PROFILE
     MONITOR "ALTUS LOW ILS RWY 35" APPROACH PROFILE
```

MONITOR "ALTUS ILS RWY 35" ILS-FINAL PROFILE
MONITOR "ALTUS TACAN 17" APPROACH PROFILE
MONITOR "ALTUS VOR DME RWY 35" APPROACH PROFILE

CREW MEMBER ASSESSMENT:

SESSION 1; PILOT:

CHECK-PROC	MIN % 70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN % 70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN % 70	CRIT FACT 0.95	WGT 0.9

SESSION 1; COPILOT:

CHECK-PROC	MIN % 70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN % 70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN % 70	CRIT FACT 0.95	WGT 0.9

SESSION 1; FLIGHT ENGINEER:

CHECK-PROC	MIN % 70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN % 70	CRIT FACT 0.95	WGT 0.7

SESSION 1; CREW COORDINATION:

CHECK-PROC	MIN % 70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN % 70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN % 70	CRIT FACT 0.95	WGT 0.7

SESSION 2; PILOT:

CHECK-PROC	MIN % 70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN % 70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN % 70	CRIT FACT 0.95	WGT 0.9

SESSION 2; COPILOT:

CHECK-PROC	MIN % 70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN % 70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN % 70	CRIT FACT 0.95	WGT 0.9

SESSION 2; FLIGHT ENGINEER:

CHECK-PROC	MIN % 70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN % 70	CRIT FACT 0.95	WGT 0.7

SESSION 2; CREW COORDINATION:

CHECK-PROC	MIN % 70	CRIT FACT 0.95	WGT 1.0
NAV PROFL	MIN % 70	CRIT FACT 0.95	WGT 1.0
PARAMETER	MIN % 70	CRIT FACT 0.95	WGT 0.7

SESSION ASSESSMENT:

SESSION 1:				
PILOT	MIN %	70	CRIT FACT 0.95	WGT 2.0
COPILOT	MIN %	70	CRIT FACT 0.95	WGT 1.0
FLT ENGR	MIN %	70	CRIT FACT 0.95	WGT 2.0
CREW COORD	MIN %	70	CRIT FACT 0.95	WGT 1.5
SESSION 2:				
PILOT	MIN %	70	CRIT FACT 0.95	WGT 2.0
COPILOT	MIN %	70	CRIT FACT 0.95	WGT 1.0
FLT ENGR	MIN %	70	CRIT FACT 0.95	WGT 2.0
CREW COORD	MIN %	70	CRIT FACT 0.95	WGT 1.5

MISSION ASSESSMENT:

SESSION 1	MIN %	70	CRIT FACT 0.95	WGT 1.0
SESSION 2	MIN %	70	CRIT FACT 0.95	WGT 1.0

APPENDIX D

CODE REFERENCE FOR APPENDIX E THROUGH APPENDIX H

CODE INDEX FOR VARIABLES REFERENCED BY MONITORABLE TASKS

NAVIGATIONAL PROFILES

D - INSTRUMENT DEPARTURE
E - ENROUTE
H - HOLDING PATTERN
A - INITIAL APPROACH
L - INSTRUMENT LANDING SYSTEM (ILS)

CHECKLISTS/PROCEDURES

ALL NORMAL ONES EXCEPT "AFTER TAKEOFF/CLIMB", "CRUISE", AND "DESCENT"
"C:" FOLLOWED BY ORDINAL NUMBERS FROM CHECK.DY

MONITORABLE PARAMETERS

S: - STANDARD LIST
P: - OTHER
ORDINAL NUMBERS FROM PARAMETER.DY

VARIABLE DATA TYPES (FOLLOWING VARIABLE NAME)

1 - BOOLEAN
2 - HALF BYTE (16 VALUES OR FEWER)
3 - FULL WORD INTEGER
4 - REAL (FLOATING POINT)
5 - DOUBLE PRECISION INTEGER

MADAR SAR LOCATIONS (FOLLOWING DATA TYPE)

L<SS>/<CC>[C][F][*]

WHERE
L = "A" FOR AUTOMATIC, OR "M" FOR MANUAL
<SS> = 2-DIGIT SAR NUMBER
<CC> = 2-DIGIT CHANNEL NUMBER
C = CDPIR PARAMETER

F = FLRS PARAMETER
* = QUESTIONABLE SOURCE

OTHER SOURCE CODES

INS = INERTIAL NAVIGATION SYSTEM
FDC- = FLIGHT DIRECTOR COMPUTER
SAME = SAME SOURCE AS VARIABLE INDICATED IN COMMENT
FLYFR = COMPUTED BASED ON WHO IS FLYING

APPENDIX E

SIGNALS REQUIRED FOR AIRBORNE MONITORING

MONVAR VARIABLE	DATA TYPE	SAR	NAVIGATIONAL PROFILE, CHECKLIST/PROCEDURE, PARAMETER REFERENCES
25-L-OXYGEN-QTY-IND	3		C: 57 S: 01
25-L-OXYGEN-QTY-LOW-LT	1		C: 57
25-L-OXYGEN-QTY-TEST-SW	1		C: 57
75-L-OXYGEN-QTY-IND	3		C: 57 S: 02
75-L-OXYGEN-QTY-LOW-LT	1		C: 57
75-L-OXYGEN-QTY-TEST-SW	1		C: 57
A-MLG-SPIN-TEST-SW	2		C: 63
A-PITCH-TRIM-GROUND-SW	2		C: 61
A-PITCH-TRIM-POWER-SW	2		C: 61
A-TRIM-TEST-SW	2		C: 61
A/C-WEIGHT	4		C: 13, 21
A/P-ALT-HOLD-SW	1		C: 62
A/P-DISC-SW	1		C: 62
A/P-PITCH-OFF-LT	1		C: 62
A/P-PITCH-WHEEL	3		C: 62
A/P-ROLL-OFF-LT	1		C: 62
A/P-TURN	3		C: 62
AC-FREQUENCY-METER	3		S: 03
AC-VOLTMETER	3		S: 04
ADF-REL-BEARING	3	FLYER	H
ADF1-FREQUENCY	3		DEHA
ADF1-FUNC-SW	2		DEHA
ADF1-REL-BEARING	3		H
ADF2-FREQUENCY	3		DEHA
ADF2-FUNC-SW	2		DEHA
ADF2-REL-BEARING	3		H
AERIAL-REF-BOOM-LATCH-SW	1		C: 57
AERIAL-REFUEL-DOORS-SW	1		C: 57
AERIAL-REFUEL-ELEC-PWR	1		C: 57
AFCS-RESET/FAIL-BUTTON	1		C: 62
AFCS-TEST-LT	1		C: 62
AIR-CONDITIONING-SW	2	A01/14	C: 19, 25, 57, 92
AIRFLOW-SW	2		C: 57
AIRSPEED	3		C: 14, 64 S: 05, 47, 57, 69, 75
ALDCS-SW	1	A14/10	C: 04, 24, 62
ALTITUDE	4	A06/30F	DEHAL S: 01, 02, 05, 57
ALTITUDE-AGL	3		C: 09, 64, 91, 94 S: 05, 07, 08, 47, 71, 75
ANGLE-OF-ATTACK	3		S: 06
APU-GEN-SELECT-SW	2		C: 03, 12, 19, 21, 56, 92 S: 03, 04

MONVAR VARIABLE	DATA TYPE	SAR	NAVIGATIONAL PROFILE, CHECKLIST/PROCEDURE, PARAMETER REFERENCES
APU/EXT-POWER-SW	2		C: 03, 12, 19, 21, 56, 92 S: 04 P: 46
AUTO-REFUEL-SW	1		C: 09, 44
AVIONICS-FAN-SW	1		C: 57
AVIONICS-ZONE-WARN	1		C: 59
BAILOUT-ALARM-SW	1		C: 63
BANK	3	INS	DE
BATTERY-SELECT-SW	2		C: 12, 21
BRAKE-PRES-NORM	3		C: 12
BRAKE-SUPPLY-SELECT-SW	2		C: 12, 14, 22, 26, 45, 60, 63
BRAKES-LT	1		C: 20, 22, 45, 60, 63
BUS-TIE1-OPEN-LT	1		C: 92
BUS-TIE2-OPEN-LT	1		C: 92
BUS-TIE3-OPEN-LT	1		C: 92
BUS-TIE4-OPEN-LT	1		C: 92
C-ALTITUDE	4	SAME	DEHA ; AS ALTITUDE
C-CADC-SW	2		C: 63
C-CDI	4	FDC2	DEHAL
C-CDI-WARNING	1	FDC2	DEHAL
C-COURSE-SET	3		DEH
C-DUCT-OVERHEAT-LT	1		C: 57
C-G/S-DEVIATION-IND	4	FDC2	L
C-G/S-DEVIATION-WARN	1	FDC2	L
C-NAV-SELECT	2	FDC2	DEHAL
C-PITOT-HEAT-SW	1		C: 04, 12, 63, 68
C-RADAR-ALT-SW	1		C: 22
C-RATE-OF-TURN	4	SAME	AL ; AS RATE-OF-TURN
C-ROLL-HUB-FORCE	3		DEHAL C: 62
C-SEPARATION-SW	1		C: 44, 58
CABIN-FLIGHT-ALT	3		S: 07
CABIN-PRES-DIFFERENCE	4		C: 03 S: 08
CABIN-PRES-MODE-SW	2		C: 23, 57, 95
CABIN-ROC-CON	3		C: 57
CARGO-SW	2	A03/28	C: 57
CDI	4	FLYER	DEHAL
CDI-WARNING	1	FLYER	DEHAL
CMA-MESSAGE	5		C: 13, 21
COLUMN-POS-CMD	4		C: 61
CONTINUOUS-IGNITION	1		C: 12, 45, 93
COURSE-SET	3	FLYER	DEH
CSD1-DISCONNECT-SW	1		C: 12, 92 S: 03, 09
CSD1-FAIL-LT	1		C: 92
CSD1-OIL-TEMP	3		S: 09
CSD2-DISCONNECT-SW	1		C: 12, 92 S: 03, 10
CSD2-FAIL-LT	1		C: 92
CSD2-OIL-TEMP	3		S: 10
CSD3-DISCONNECT-SW	1		C: 12, 92 S: 03, 11
CSD3-FAIL-LT	1		C: 92
CSD3-OIL-TEMP	3		S: 11

MONVAR VARIABLE	DATA TYPE	SAR	NAVIGATIONAL PROFILE, CHECKLIST/PROCEDURE, PARAMETER REFERENCES
CSD4-DISCONNECT-SW	1		C: 12, 92 S: 03, 12
CSD4-FAIL-LT	1		C: 92
CSD4-OIL-TEMP	3		S: 12
DC-VOLTMETER	3		S: 13
DCVM-SELECT-SW	2		C: 12 S: 13
ELEV-FEEL-SYS1-SW	1		C: 12
ELEV-FEEL-SYS4-SW	1		C: 12
EMER-DEPRESS-SW	1		C: 57
ENG-&-APU-FIRE-DET-SW	2		C: 56
ENG1-A/I-SW	2	A04/20	C: 10, 25, 44, 57, 92
ENG1-AUG-AIR-SW	1		C: 44, 57, 92
ENG1-BLEED-AIR-SW	1	A04/16	C: 57, 92 S: 54
ENG1-EPR	4	A19/30C	C: 94 S: 14
ENG1-FIRE-HANDLE	1		C: 59
ENG1-FUEL-&-START-IGN	2		C: 12, 45, 93 S: 19 P: 20
ENG1-FUEL-FLOW	3	A03/22C	S: 15
ENG1-FUEL-HEATER-SW	1	A04/15	C: 58
ENG1-LOW-OIL-PRES-LT	1		C: 93
ENG1-N1-RPM	3	A04/14C	P: 16
ENG1-N2-RPM	3	A04/09C	C: 92, 93 S: 04, 17, 18, 76
ENG1-OIL-PRESSURE	3	A03/07C	S: 18
ENG1-OIL-TEMP	3	A19/04	S: 18, 19
ENG1-START-BUTTON	1		C: 93 S: 15
ENG1-START-CYCLE	1		P: 20
ENG1-START-VALVE-OPEN-LT	1		C: 92, 93
ENG1-TIT	3	A04/29C	C: 94 S: 15, 21
ENG2-A/I-SW	1	A04/21	C: 10, 25, 44, 57, 92
ENG2-AUG-AIR-SW	1		C: 44, 57, 92
ENG2-BLEED-AIR-SW	1	A04/17	C: 57, 92 S: 54
ENG2-FIRE-HANDLE	1		C: 59
ENG2-FUEL-&-START-IGN	2		C: 12, 45, 93 S: 25 P: 28
ENG2-FUEL-FLOW	3	A03/18C	S: 22
ENG2-FUEL-HEATER-SW	1	A04/11	C: 58
ENG2-LOW-OIL-PRES-LT	1		C: 93
ENG2-N2-RPM	3	A04/02C	C: 92, 93 S: 04, 23, 24, 77
ENG2-OIL-PRESSURE	3	A03/03C	S: 24
ENG2-OIL-TEMP	3	A20/04	S: 24, 25
ENG2-P-EPR	4	A20/30C	C: 94 S: 26
ENG2-P-N1-RPM	3	A04/13C	P: 27
ENG2-REV-TH-EMER-RET-SW	1		C: 59
ENG2-START-BUTTON	1		C: 93 S: 22
ENG2-START-CYCLE	1		P: 28
ENG2-START-VALVE-OPEN-LT	1		C: 92, 93
ENG2-TIT	3	A04/25C	C: 94 S: 22, 29
ENG3-A/I-SW	1	A04/22	C: 10, 25, 44, 57, 92
ENG3-AUG-AIR-SW	1		C: 44, 57, 92
ENG3-BLEED-AIR-SW	1	A04/18	C: 57, 92 S: 73
ENG3-EPR	4	A21/30C	C: 94 S: 30
ENG3-F-N2-RPM	3	A04/06C	C: 92 S: 04, 33

MONVAR VARIABLE	DATA TYPE	SAR	NAVIGATIONAL PROFILE, CHECKLIST/PROCEDURE, PARAMETER REFERENCES
ENG3-FIRE-HANDLE	1		C: 59
ENG3-FUEL-&-START-IGN	2		C: 12, 45, 93 S: 34 P: 36
ENG3-FUEL-FLOW	3	A03/26C	S: 31
ENG3-FUEL-HEATER-SW	1	A04/07	C: 58
ENG3-LOW-OIL-PRES-LT	1		C: 93
ENG3-N1-RPM	3	A04/01C	P: 32
ENG3-OIL-PRESSURE	3	A03/05C	S: 32
ENG3-OIL-TEMP	3	A21/04	S: 33, 34
ENG3-P-N2-RPM	3	A04/06C	C: 93 S: 35, 78
ENG3-REV-TH-EMER-RET-SW	1		C: 59
ENG3-START-BUTTON	1		C: 93 S: 31
ENG3-START-CYCLE	1		P: 36
ENG3-START-VALVE-OPEN-LT	1		C: 92, 93
ENG3-TIT	3	A04/26C	C: 94 S: 31, 37
ENG4-A/I-SW	1	A04/23	C: 10, 25, 44, 57, 92
ENG4-AUG-AIR-SW	1		C: 44, 57, 92
ENG4-BLEED-AIR-SW	1	A04/19	C: 57, 92 S: 73
ENG4-EPR	4	A22/30C	C: 94 S: 38
ENG4-F-N2-RPM	3	A04/05C	C: 92 S: 04, 39
ENG4-FIRE-HANDLE	1		C: 59
ENG4-FUEL-&-START-IGN	2		C: 12, 45, 93 S: 40 P: 45
ENG4-FUEL-HEATER-SW	1	A04/03	C: 58
ENG4-LOW-OIL-PRES-LT	1		C: 93
ENG4-OIL-PRESSURE	3	A03/01C	S: 39
ENG4-OIL-TEMP	3	A22/04	S: 39, 40
ENG4-P-FUEL-FLOW	3	A03/30C	S: 41
ENG4-P-N1-RPM	3	A04/10C	P: 42
ENG4-P-N2-RPM	3	A04/05C	C: 93 S: 43, 79
ENG4-P-TIT	3	A04/30C	C: 94 S: 41, 44
ENG4-START-BUTTON	1		C: 93 S: 41
ENG4-START-CYCLE	1		P: 45
ENG4-START-VALVE-OPEN-LT	1		C: 92, 93
ENGINE-1-RUNNING	1		C: 10, 91 S: 03, 09, 14, 15, 17, 18 P: 16, 20
ENGINE-2-RUNNING	1		C: 10 S: 03, 10, 22, 23, 24, 26 P: 27, 28
ENGINE-3-RUNNING	1		C: 10 S: 03, 11, 30, 31, 33, 35 P: 32, 36
ENGINE-4-RUNNING	1		C: 10 S: 03, 12, 38, 39, 41, 43 P: 42, 45
EXT-ELECTRIC-POWER	1		C: 19, 21, 56 P: 46
EXT-POWER-LOADMETER	4		P: 46
EXT-POWER-LT	1		C: 12
F-MLG-SPIN-TEST-SW	2		C: 63
FILL-MAIN1-SW	1		C: 09, 44, 91
FILL-MAIN2-SW	1		C: 09, 44, 91
FILL-MAIN3-SW	1		C: 09, 44, 91
FILL-MAIN4-SW	1		C: 09, 44, 91
FLAP-HANDLE	3		C: 04, 14, 61 S: 05

MONVAR VARIABLE	DATA TYPE	SAR	NAVIGATIONAL PROFILE, CHECKLIST/PROCEDURE, PARAMETER REFERENCES
FLAP-POS-IND	3	A18/29CF	C: 14, 22, 24, 26, 60, 68, 94 S: 05, 14, 26, 30, 38, 47 P: 82
FLIGHT-L-SYS-A-SW	1		C: 12
FLIGHT-L-SYS-B-SW	1		C: 12
FLIGHT-R-SYS-A-SW	1		C: 12
FLIGHT-R-SYS-B-SW	1		C: 12
FLIGHT-STA-SW	2	A03/16	C: 57
FLOOR-HEAT-SW	2	A01/09	C: 09, 21, 44, 57, 59
FSS-ARM-SW	1		C: 59
FUEL-DIF-MAINS-1&2	4		C: 09
FUEL-DIF-MAINS-3&4	4		C: 09
FUEL-ISO-VALVE-1-SW	1		C: 44, 58
FUEL-ISO-VALVE-2-SW	1		C: 44, 58
FUEL-ISO-VALVE-3-SW	1		C: 44, 58
FUEL-ISO-VALVE-4-SW	1		C: 44, 58
FUEL-QTY-IND-EXRG1	4		C: 58
FUEL-QTY-IND-EXRG2	4		C: 58
FUEL-QTY-IND-EXRG3	4		C: 58
FUEL-QTY-IND-EXRG4	4		C: 58
FUEL-QTY-TEST-AUX1	1		C: 58
FUEL-QTY-TEST-AUX2	1		C: 58
FUEL-QTY-TEST-AUX3	1		C: 58
FUEL-QTY-TEST-AUX4	1		C: 58
FUEL-QTY-TEST-EXRG1	1		C: 58
FUEL-QTY-TEST-EXRG2	1		C: 58
FUEL-QTY-TEST-EXRG3	1		C: 58
FUEL-QTY-TEST-EXRG4	1		C: 58
FUEL-QTY-TEST-MAIN1	1		C: 58
FUEL-QTY-TEST-MAIN2	1		C: 58
FUEL-QTY-TEST-MAIN3	1		C: 58
FUEL-QTY-TEST-MAIN4	1		C: 58
FUEL-TEMP-SELECT-SW	2		C: 23
GEN-VOLTS-&-FREQ-SW	2	M01/03	C: 03, 21, 56, 92 S: 03, 04
GEN1-BUS-TIE-SW	2		C: 03, 12 P: 80
GEN1-LOADMETER	4		P: 48
GEN1-OUT-LT	1		C: 92
GEN1-SW	2		C: 03, 12 S: 03, 04 P: 48
GEN2-BUS-TIE-SW	2		C: 03, 12
GEN2-LOADMETER	4		P: 49
GEN2-OUT-LT	1		C: 92 P: 49
GEN2-SW	2		C: 03, 12 S: 03, 04
GEN3-BUS-TIE-SW	2		C: 03, 12
GEN3-LOADMETER	4		P: 50
GEN3-OUT-LT	1		C: 92
GEN3-SW	2		C: 03, 12 S: 03, 04 P: 50
GEN4-BUS-TIE-SW	2		P: 81
GEN4-LOADMETER	4		P: 51
GEN4-OUT-LT	1		C: 92
GEN4-SW	2		C: 03, 12 S: 03, 04 P: 51

MONVAR VARIABLE	DATA TYPE	SAR	NAVIGATIONAL PROFILE, CHECKLIST/PROCEDURE, PARAMETER REFERENCES
GROUND-L-SYS-A-SW	1		C: 12
GROUND-L-SYS-B-SW	1		C: 12
GROUND-R-SYS-A-SW	1		C: 12
GROUND-R-SYS-B-SW	1		C: 12
GROUND-SPEED	3	INS?	S: 63, 64, 65, 66, 68 P: 52
GROUND-SPOILER-HANDLE	3	A08/01F*	C: 04, 12, 24, 61, 64
GSI	4	FLYER	L
GSI-WARNING	1	FLYER	L
HORN-SW	2		C: 59
I-FUEL-PUMP-AUX1	1		C: 03, 58, 91
I-FUEL-PUMP-AUX2	1		C: 03, 58, 91
I-FUEL-PUMP-AUX3	1		C: 03, 58, 91
I-FUEL-PUMP-AUX4	1		C: 03, 58, 91
I-FUEL-PUMP-EXRG1	1		C: 03, 09, 58, 91
I-FUEL-PUMP-EXRG2	1		C: 03, 09, 58, 91
I-FUEL-PUMP-EXRG3	1		C: 03, 09, 58, 91
I-FUEL-PUMP-EXRG4	1		C: 03, 09, 58, 91
I-FUEL-PUMP-MAIN1	1		C: 03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN2	1		C: 03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN3	1		C: 03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN4	1		C: 03, 09, 58, 63, 91
ICE-ARMED-SW	1		C: 10, 25, 92
ICE-DETECT-TEST-SW	1		C: 25
ICE-DETECTOR-SW	2		C: 10, 25, 26, 44
INS1-MSU-MODE-SW	2		C: 45, 59
INS1/3-ROLL	3	SAME	DE ; AS BANK
INS2-MSU-MODE-SW	2		C: 45, 59
INS2/3-ROLL	3	SAME	DE ; AS BANK
INS3-MSU-MODE-SW	2		C: 45, 59
INSTRUMENT-POWER-SW	2		C: 12, 45
ISO-BUS-SW	1		C: 12
KEYSET	5		C: 44, 63
KNEEL-COMMAND-SW	2		C: 57
KNEEL-SELECT-SW	2		C: 57
L-AERIAL-REFUEL-SW	1		C: 57
L-AIL-SYS1-SW	1		C: 12, 62
L-AIL-SYS2-SW	1		C: 12, 62
L-AIL-TRIM-IND	4		C. 24, 61
L-AOA-VANE-HEATER-SW	1		C: 04, 12, 63, 68
L-CROSSFEED-SW	1		C: 03, 09, 44, 58, 91
L-DUCT-OVERHEAT-LT	1		S: 54
L-DUCT-OVERHEAT-SW	2		C: 57
L-FLOW-CONTROL-SW	1	A05/04	C: 57
L-FUEL-JETT-SW	1		C: 58
L-GROUND-REFUEL-SW	2		C: 58
L-I-ELEV-SYS2-SW	1		C: 12, 61, 62
L-I-ELEV-SYS3-SW	1		C: 12, 22, 59, 61, 62
L-I-WING-DIS-SW	1		C: 59
L-LANDING-LIGHT-SW	1		C: 09, 11, 60, 68, 91 P: 53

MONVAR VARIABLE	DATA TYPE	SAR	NAVIGATIONAL PROFILE, CHECKLIST/PROCEDURE, PARAMETER REFERENCES
L-MAIN-WW-DIS-SW	1		C: 59
L-MANIFOLD-PRESSURE	3	A07/17,25	S: 54
L-O-WING-DIS-SW	1		C: 59
L-PTU-DIS-SW	1		C: 59
L-RATIO-SHIFTER-SW	2		C: 12
L-RUDDER-SYS2-SW	1		C: 12, 62
L-RUDDER-SYS3-SW	1		C: 12, 62
L-SEPARATION-SW	1		C: 09, 44, 58, 91
L-WING-ISO-SW	1		C: 57
L-WING-VENT-OPEN	1		C: 59
L-WING-VENT-SW	1		C: 59
LANDING-GEAR-LEVER	1	A01/03	C: 10, 11, 12, 13, 14, 94 S: 55 P: 59, 60, 61, 62, 67
LAPU-BLEED-AIR-SW	1		C: 03, 19, 21, 56, 57, 92 S: 54, 73
LAPU-CONT-SW	2		C: 03, 19, 21, 25, 56 S: 56
LAPU-DOOR-OPEN-LT	1		C: 21, 56
LAPU-EGT-IND	3	A03/02	S: 56
LAPU-FIRE-HANDLE	1		C: 56
LAPU-ISO-SW	1		C: 03, 23, 57
LAPU-ISO-VALVE-OPEN-LT	1		C: 57
LAPU-ON-SPEED-LT	1		C: 03, 21 S: 03, 04, 56
LAPU-START-LT	1		C: 21, 56
LATERAL-AUG-OFF-LT	1		C: 62
LATERAL-AUG-SW	1	A17/07	C: 22, 26, 45
LATITUDE	5	INS	DEHAL
LONGITUDE	5	INS	DEHAL
MACH	4	A05/30F	S: 05, 57
MADAR-OPERATE	1		C: 21
MADAR-POWER	1		C: 21
MAG-HEADING	3		EHAL S: 58
MAIN-BUS1-AFT-OFF-LT	1		C: 56
MAIN-BUS1-FWD-OFF-LT	1		C: 56
MAIN-BUS2-AFT-OFF-LT	1		C: 56
MAIN-BUS2-FWD-OFF-LT	1		C: 56
MAIN-BUS3-AFT-OFF-LT	1		C: 56
MAIN-BUS3-FWD-OFF-LT	1		C: 56
MAIN-BUS4-AFT-OFF-LT	1		C: 56
MAIN-BUS4-FWD-OFF-LT	1		C: 56
MAIN1-SUMP-LOW-TEST-SW	2		C: 58
MAIN4-SUMP-LOW-TEST-SW	2		C: 58
MANUAL-CABIN-PRES	3		C: 57
MASTER-POWER-ON-LATERAL	1		C: 20, 62
MASTER-POWER-ON-PITCH	1		C: 62
MLG-CASTER-SW	1		C: 59, 68
MLG-EMER-EXT-L-A	1		P: 59
MLG-EMER-EXT-L-F	1		P: 60
MLG-EMER-EXT-R-A	1		P: 61
MLG-EMER-EXT-R-F	1		P: 62
MLG-IND-L-A	2		S: 05 P: 59

MONVAR VARIABLE	DATA TYPE	SAR	NAVIGATIONAL PROFILE, CHECKLIST/PROCEDURE, PARAMETER REFERENCES
MLG-IND-L-F	2		P: 60
MLG-IND-R-A	2		P: 61
MLG-IND-R-F	2		P: 62
MLG-ON-GROUND	1		C: 64
MLG-POS-IND-L-A	4		C: 68 S: 63
MLG-POS-IND-L-F	4		C: 68 S: 64
MLG-POS-IND-R-A	4		C: 68 S: 65
MLG-POS-IND-R-F	4		C: 68 S: 66
MON-BUS2-OVRD-SW	1		C: 03, 12, 21, 56, 92
MON-BUS3-OVRD-SW	1		C: 03, 12, 21, 56, 92
NFS-TEST-SW	2		C: 59
NLG-EMER-EXT-SW	1		P: 67
NLG-IND	2		S: 05, 57 P: 67
NLG-ON-GROUND	1		C: 64
NLG-POS-XWIND-IND	4		C: 68 S: 68
NLG-STEERING-IND	4		S: 69
NLG-STEERING-SW	1		C: 59
NOSE-LANDING-LIGHT-SW	1		C: 11, 60, 68 P: 70
NOSE-WHEEL-WELL-DIS-SW	1		C: 59
O-ELEV-SYS1-SW	1		C: 12
O-ELEV-SYS2-SW	1		C: 12
O-ELEV-SYS3-SW	1		C: 12
O-FUEL-PUMP-AUX1	1		C: 03, 09, 58, 91
O-FUEL-PUMP-AUX2	1		C: 03, 09, 58, 91
O-FUEL-PUMP-AUX3	1		C: 03, 09, 58, 91
O-FUEL-PUMP-AUX4	1		C: 03, 09, 58, 91
O-FUEL-PUMP-EXRG1	1		C: 03, 09, 58, 91
O-FUEL-PUMP-EXRG2	1		C: 03, 09, 58, 91
O-FUEL-PUMP-EXRG3	1		C: 03, 09, 58, 91
O-FUEL-PUMP-EXRG4	1		C: 03, 09, 58, 91
O-FUEL-PUMP-MAIN1	1		C: 03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN2	1		C: 03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN3	1		C: 03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN4	1		C: 03, 09, 58, 63, 91
ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74,75 P: 52, 82, 83, 84
P-ALTITUDE	4	SAME	DEHA ; AS ALTITUDE
P-CADC-SW	2		C: 62
P-CDI	4	FDC1	DEHAL
P-CDI-WARNING	1	FDC1	DEHAL
P-COURSE-SET	3		DEH
P-G/S-DEVIATION-IND	4	FDC1	L
P-G/S-DEVIATION-WARN	1	FDC1	L
P-NAV-SELECT	2	FDC1	DEHAL
P-PITOT-HEAT-SW	1		C: 04, 12, 63, 68
P-RADAR-ALT-SW	1		C: 09, 22, 63, 91
P-RATE-OF-TURN	4	SAME	AL ; AS RATE-OF-TURN

MONVAR VARIABLE	DATA TYPE	SAR	NAVIGATIONAL PROFILE, CHECKLIST/PROCEDURE, PARAMETER REFERENCES
P-ROLL-HUB-FORCE	3		DEHAL C: 61
PACS-PITCH-SW	1		C: 12, 20, 61
PACS-ROLL-SW	1		C: 12, 20, 61
PHASE-SELECT-SW	2		C: 03, 56
PITCH	3	FDC	S: 71
PITCH-AUG-OFF-LT	1		C: 62
PITCH-AUG-SW	1	A17/27	C: 22, 26, 45
PITCH-C-HUB-FORCE	3		DEHAL C: 62
PITCH-P-HUB-FORCE	3		DEHAL C: 61
PITCH-TRIM-GROUND-SW	2		C: 61, 62
PITCH-TRIM-IND	4		C: 24, 61
PITCH-TRIM-MANUAL-LEVER	3		C: 61
PITCH-TRIM-MANUAL-SW	1		C: 61
PITCH-TRIM-POWER-SW	2		C: 61, 62
PRE-CHECK-SW	2		C: 58
PTU-1/2-SW	1		C: 10, 11, 25, 44, 59, 63, 92 S: 77
PTU-2/3-SW	1		C: 44, 59, 63, 92 S: 77, 78
PTU-3/4-SW	1		C: 10, 11, 25, 44, 59, 63 S: 78
R-AERIAL-REFUEL-SW	1		C: 57
R-AIL-SYS2-SW	1		C: 12, 62
R-AIL-SYS4-SW	1		C: 12, 62
R-AIL-TRIM-IND	4		C: 24, 61
R-CROSSFEED-SW	1		C: 03, 09, 44, 58, 91
R-DUCT-OVERHEAT-LT	1		S: 73
R-DUCT-OVERHEAT-SW	2		C: 57
R-FLOW-CONTROL-SW	1	A10/30	C: 57
R-FUEL-JETT-SW	1		C: 58
R-GROUND-REFUEL-SW	2		C: 58
R-I-ELEV-SYS2-SW	1		C: 12, 22, 59, 61, 62
R-I-ELEV-SYS3-SW	1		C: 12, 61, 62
R-I-WING-DIS-SW	1		C: 59
R-LANDING-LIGHT-SW	1		C: 09, 11, 60, 68, 91 P: 72
R-MAIN-WW-DIS-SW	1		C: 59
R-MANIFOLD-PRESSURE	3	A07/10,14	S: 73
R-O-WING-DIS-SW	1		C: 59
R-PTU-DIS-SW	1		C: 59
R-RATIO-SHIFTER-SW	2		C: 12
R-SEPARATION-SW	1		C: 09, 44, 58, 91
R-WING-ISO-SW	1		C: 57
R-WING-VENT-OPEN	1		C: 59
R-WING-VENT-SW	1		C: 59
RAPU-BLEED-AIR-SW	1		C: 03, 19, 21 56, 57, 92
RAPU-CONT-SW	2		C: 03, 19, 21, 25, 56 S: 74
RAPU-DOOR-OPEN-LT	1		C: 03, 21, 56
RAPU-EGT-IND	3	A03/06	S: 74
RAPU-FIRE-HANDLE	1		C: 56
RAPU-ISO-SW	1		C: 03, 23, 57
RAPU-ISO-VALVE-OPEN-LT	1		C: 57
RAPU-ON-SPEED-LT	1		C: 03, 21 S: 03, 04, 74

MONVAR VARIABLE	DATA TYPE	SAR	NAVIGATIONAL PROFILE, CHECKLIST/PROCEDURE, PARAMETER REFERENCES
RAPU-START-LT	1		C: 03, 21, 56
RAT-SW	2		C: 04, 12, 24
RATE-OF-TURN	4		AL
RECIRC-FAN-SW	1		C: 25, 44, 57
REFUEL-AUX1-SW	1		C: 09, 44, 91
REFUEL-AUX2-SW	1		C: 09, 44, 91
REFUEL-AUX3-SW	1		C: 09, 44, 91
REFUEL-AUX4-SW	1		C: 09, 44, 91
REFUEL-EXRG1-SW	1		C: 09, 44, 91
REFUEL-EXRG2-SW	1		C: 09, 44, 91
REFUEL-EXRG3-SW	1		C: 09, 44, 91
REFUEL-EXRG4-SW	1		C: 09, 44, 91
RELIEF-CREW-SW	2	A03/20	C: 57
ROLL	3	SAME	S: 75 P: 82 ; AS BANK
RUDDER-LIMIT-SW	1		C: 04, 24
RUDDER-LIMITER	1		C: 12
RUDDER-PEDAL	4		C: 24, 61
RUDDER-TRIM-GROUND-SW	1		C: 61
RUDDER-TRIM-IND	4		C: 24
RUDDER-TRIM-POWER-SW	2		C: 61
SHORT-DISC-SW	1		C: 56
SKID-CONTROL-SW	2		C: 04, 22, 60, 68, 94
SKID-CONTROL-TEST-1-SW	1		C: 60
SKID-CONTROL-TEST-2-SW	1		C: 60
SKID-CONTROL-TEST-3-SW	1		C: 60
SLAT-DRIVE-SW	1		C: 12
SLAT-POS-IND	1		C: 24, 68
STALLIMITER1-OFF-LT	1		C: 20
STANDBY-COMPASS	3	SAME	H ; AS MAG-HEADING
SYS1-ATM-PUMP-PRESS-LT	1		C: 21, 44, 59
SYS1-ATM-PUMP-SW	1		C: 19, 21, 44, 59, 63, 92 S: 76
SYS1-ATM-START-SW	1		C: 21, 44, 59 S: 76
SYS1-ATM-VALVE-OPEN-LT	1		C: 21, 44, 59
SYS1-BOOST-PRES-LOW-LT	1		C: 10, 92
SYS1-BOOST-PUMP-SW	1		C: 10, 11, 19, 21, 59, 63
SYS1-BOT-PRES-LOW-LT	1		C: 92
SYS1-BOT-SW	1		C: 19, 21, 25, 44, 92 S: 76
SYS1-FLUID-EMPTY	1		C: 10
SYS1-HYD-PRESSURE	3		C: 21, 25, 92 S: 76, 77
SYS1-TOP-PRES-LOW-LT	1		C: 92
SYS1-TOP-SW	1		C: 19, 21, 25, 44 S: 76
SYS2-BOOST-PRES-LOW-LT	1		C: 10, 92
SYS2-BOT-PRES-LOW-LT	1		C: 92
SYS2-BOT-SW	1		C: 19, 21, 44, 92 S: 77
SYS2-HYD-PRESSURE	3		C: 92 S: 77, 78
SYS2-TOP-PRES-LOW-LT	1		C: 92
SYS2-TOP-SW	1		C: 19, 21, 44 S: 77
SYS3-BOOST-PRES-LOW-LT	1		C: 10, 92
SYS3-BOT-PRES-LOW-LT	1		C: 92

MONVAR VARIABLE	DATA TYPE	SAR	NAVIGATIONAL PROFILE, CHECKLIST/PROCEDURE, PARAMETER REFERENCES
SYS3-BOT-SW	1		C: 19, 21, 44, 92 S: 78
SYS3-HYD-PRESSURE	3		C: 92 S: 77, 78
SYS3-TOP-PRES-LOW-LT	1		C: 92
SYS3-TOP-SW	1		C: 19, 21, 44 S: 78
SYS4-ATM-PUMP-PRESS-LT	1		C: 21, 44, 59
SYS4-ATM-PUMP-SW	1		C: 19, 21, 44, 59, 63, 92 S: 79
SYS4-ATM-START-SW	1		C: 21, 44, 59 S: 79
SYS4-ATM-VALVE-OPEN-LT	1		C: 21, 44, 59
SYS4-BOOST-PRES-LOW-LT	1		C: 92
SYS4-BOOST-PUMP-SW	1		C: 10, 11, 19, 21, 59, 63
SYS4-BOT-PRES-LOW-LT	1		C: 10, 92
SYS4-BOT-SW	1		C: 19, 21, 25, 44, 92 S: 79
SYS4-FLUID-EMPTY	1		C: 10
SYS4-HYD-PRESSURE	3		C: 21, 25, 92 S: 78, 79
SYS4-TOP-PRES-LOW-LT	1		C: 92
SYS4-TOP-SW	1		C: 19, 21, 25, 44 S: 79
T/R1-DC-LOAD	4		P: 80
T/R2-DC-LOAD	4		P: 81
TACAN-DME	4	FDC1	D A
TACAN1-ANT-SW	2		DEHA
TACAN1-CHANNEL	3		DEHA
TACAN1-DME	4	SAME	D A ; AS TACAN-DME
TACAN1-FUNC-SW	2		DEHA
TACAN1-MODE-SW	1		DEHA
TACAN2-DME	4	SAME	D A ; AS TACAN-DME
THROTTLE1	3	A01/30C	C: 22, 64, 68, 93, 94 S: 14, 58, 71
THROTTLE2	3	A01/29C	D C: 22, 64, 68, 93, 94 S: 26, 58, 71
THROTTLE3	3	A01/26C	D C: 22, 64, 68, 93, 94 S: 30
THROTTLE4	3	A01/25C	C: 22, 64, 68, 93, 94 S: 38
TOTAL-FUEL-QTY	4	A08/13F	C: 09, 91
TROOP-CMPT-SW	2	A03/24	C: 57
U-AOA-VANE-HEATER-SW	1		C: 04, 12, 63, 68
U-RUDDER-SYS1-SW	1		C: 12, 62
U-RUDDER-SYS3-SW	1		C: 12, 62
UHF1-MODE-SW	2		C: 12, 22, 56
UHF2-MODE-SW	2		C: 12, 22, 56
UNDERFLOOR-AFT-DIS-SW	1		C: 59
UNDERFLOOR-FWD-DIS-SW	1		C: 59
UNDERFLOOR-MID-DIS-SW	1		C: 59
VERT-ACCELEROMETER	4	A05/21F	P: 82
VERTICAL-SPEED	3		S: 05, 47, 57, 71 P: 83
VOR1-FREQUENCY	4		DEHAL
VOR1-SW	1		DEHAL
VOR2-FREQUENCY	4		DEHAL
VOR2-SW	1		DEHAL
WW-ISO-VALVE-OPEN-LT	1		C: 21
XWIND-POS-CON	4		C: 04, 14, 59, 68
XWIND-SW	1		C: 59

MONVAR VARIABLE	DATA TYPE	SAR	NAVIGATIONAL PROFILE, CHECKLIST/PROCEDURE, PARAMETER REFERENCES
YAW	4		P: 84
YAW-AUG-MANUAL-TRIM	4		C: 62
YAW-AUG-OFF-LT	1		C: 62
YAW-AUG-SW	1	A17/15	C: 22, 26, 45

APPENDIX F

SIGNALS REQUIRED FOR INDIVIDUAL CHECKLISTS

CHECKLIST INDEX

INDEX	NAME
3F	AFTER LANDING
4P	AFTER LANDING
10F	APPROACH
11P	APPROACH
12F	BEFORE INTERIOR
13F	BEFORE LANDING
14P	BEFORE LANDING
19F	BEFORE LEAVING AIRPLANE
20P	BEFORE LEAVING AIRPLANE
21F	BEFORE STARTING ENGINES
22P	BEFORE STARTING ENGINES
23F	BEFORE TAKE OFF
24P	BEFORE TAKE OFF
25F	BEFORE TAXI
26P	BEFORE TAXI
44F	ENGINE SHUTDOWN
45P	ENGINE SHUTDOWN
56F	INTERIOR (1-15)
57F	INTERIOR (16-30)
58F	INTERIOR (31-37)
59F	INTERIOR (38-60)
60F	INTERIOR (61-66)
61F	INTERIOR (67-73)
62F	INTERIOR (74-80)
63F	INTERIOR (81-105)
64P	LANDING
91F	STANDARD FUEL MANAGEMENT
68P	LINEUP
92F	STARTING ENGINES
93P	STARTING ENGINES
94P	TAKEOFF THROTTLE SETTING
95P	TAXI

APU-GEN-SELECT-SW	2		C: 03, 12, 19, 21, 56, 92 S: 03, 04
APU/EXT-POWER-SW	2		C: 03, 12, 19, 21, 56, 92 S: 04 P: 46
CABIN-PRES-DIFFERENCE	4		C: 03 S: 08
GEN-VOLTS-&-FREQ-SW	2	M01/03	C: 03, 21, 56, 92 S: 03, 04
GEN1-BUS-TIE-SW	2		C: 03, 12 P: 80
GEN1-SW	2		C: 03, 12 S: 03, 04 P: 48
GEN2-BUS-TIE-SW	2		C: 03, 12
GEN2-SW	2		C: 03, 12 S: 03, 04
GEN3-BUS-TIE-SW	2		C: 03, 12
GEN3-SW	2		C: 03, 12 S: 03, 04 P: 50
GEN4-SW	2		C: 03, 12 S: 03, 04 P: 51
I-FUEL-PUMP-AUX1	1		C: 03, 58, 91
I-FUEL-PUMP-AUX2	1		C: 03, 58, 91
I-FUEL-PUMP-AUX3	1		C: 03, 58, 91
I-FUEL-PUMP-AUX4	1		C: 03, 58, 91
I-FUEL-PUMP-EXRG1	1		C: 03, 09, 58, 91
I-FUEL-PUMP-EXRG2	1		C: 03, 09, 58, 91
I-FUEL-PUMP-EXRG3	1		C: 03, 09, 58, 91
I-FUEL-PUMP-EXRG4	1		C: 03, 09, 58, 91
I-FUEL-PUMP-MAIN1	1		C: 03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN2	1		C: 03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN3	1		C: 03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN4	1		C: 03, 09, 58, 63, 91
L-CROSSFEED-SW	1		C: 03, 09, 44, 58, 91
LAPU-BLEED-AIR-SW	1		C: 03, 19, 21, 56, 57, 92 S: 54, 73
LAPU-CONT-SW	2		C: 03, 19, 21, 25, 56 S: 56
LAPU-ISO-SW	1		C: 03, 23, 57
LAPU-ON-SPEED-LT	1		C: 03, 21 S: 03, 04, 56
MON-BUS2-OVRD-SW	1		C: 03, 12, 21, 56, 92
MON-BUS3-OVRD-SW	1		C: 03, 12, 21, 56, 92
O-FUEL-PUMP-AUX1	1		C: 03, 09, 58, 91
O-FUEL-PUMP-AUX2	1		C: 03, 09, 58, 91
O-FUEL-PUMP-AUX3	1		C: 03, 09, 58, 91
O-FUEL-PUMP-AUX4	1		C: 03, 09, 58, 91
O-FUEL-PUMP-EXRG1	1		C: 03, 09, 58, 91
O-FUEL-PUMP-EXRG2	1		C: 03, 09, 58, 91
O-FUEL-PUMP-EXRG3	1		C: 03, 09, 58, 91
O-FUEL-PUMP-EXRG4	1		C: 03, 09, 58, 91
O-FUEL-PUMP-MAIN1	1		C: 03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN2	1		C: 03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN3	1		C: 03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN4	1		C: 03, 09, 58, 63, 91
ON-GROUND	1	A15/27 DL	C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84
PHASE-SELECT-SW	2		C: 03, 56
R-CROSSFEED-SW	1		C: 03, 09, 44, 58, 91
RAPU-BLEED-AIR-SW	1		C: 03, 19, 21 56, 57, 92

RAPU-CONT-SW	2		C: 03, 19, 21, 25, 56 S: 74
RAPU-DOOR-OPEN-LT	1		C: 03, 21, 56
RAPU-ISO-SW	1		C: 03, 23, 57
RAPU-ON-SPEED-LT	1		C: 03, 21 S: 03, 04, 74
RAPU-START-LT	1		C: 03, 21, 56

CHECKLIST 4 C.04

ALDCS-SW	1	A14/10	C: 04, 24, 62
C-PITOT-HEAT-SW	1		C: 04, 12, 63, 68
FLAP-HANDLE	3		C: 04, 14, 61 S: 05
GROUND-SPOILER-HANDLE	3	A08/01F*	C: 04, 12, 24, 61, 64
L-AOA-VANE-HEATER-SW	1		C: 04, 12, 63, 68
ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84
P-PITOT-HEAT-SW	1		C: 04, 12, 63, 68
RAT-SW	2		C: 04, 12, 24
RUDDER-LIMIT-SW	1		C: 04, 24
SKID-CONTROL-SW	2		C: 04, 22, 60, 68, 94
U-AOA-VANE-HEATER-SW	1		C: 04, 12, 63, 68
XWIND-POS-CON	4		C: 04, 14, 59, 68

CHECKLIST 9 C.09

ALTITUDE-AGL	3		C: 09, 64, 91, 94 S: 05, 07, 08, 47, 71, 75
AUTO-REFUEL-SW	1		C: 09, 44
FILL-MAIN1-SW	1		C: 09, 44, 91
FILL-MAIN2-SW	1		C: 09, 44, 91
FILL-MAIN3-SW	1		C: 09, 44, 91
FILL-MAIN4-SW	1		C: 09, 44, 91
FLOOR-HEAT-SW	2	A01/09	C: 09, 21, 44, 57, 59
FUEL-DIF-MAINS-1&2	4		C: 09
FUEL-DIF-MAINS-3&4	4		C: 09
I-FUEL-PUMP-EXRG1	1		C: 03, 09, 58, 91
I-FUEL-PUMP-EXRG2	1		C: 03, 09, 58, 91
I-FUEL-PUMP-EXRG3	1		C: 03, 09, 58, 91
I-FUEL-PUMP-EXRG4	1		C: 03, 09, 58, 91
I-FUEL-PUMP-MAIN1	1		C: 03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN2	1		C: 03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN3	1		C: 03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN4	1		C: 03, 09, 58, 63, 91
L-CROSSFEED-SW	1		C: 03, 09, 44, 58, 91
L-LANDING-LIGHT-SW	1		C: 09, 11, 60, 68, 91 P: 53
L-SEPARATION-SW	1		C: 09, 44, 58, 91
O-FUEL-PUMP-AUX1	1		C: 03, 09, 58, 91
O-FUEL-PUMP-AUX2	1		C: 03, 09, 58, 91
O-FUEL-PUMP-AUX3	1		C: 03, 09, 58, 91

O-FUEL-PUMP-AUX4	1		C:	03, 09, 58, 91
O-FUEL-PUMP-EXRG1	1		C:	03, 09, 58, 91
O-FUEL-PUMP-EXRG2	1		C:	03, 09, 58, 91
O-FUEL-PUMP-EXRG3	1		C:	03, 09, 58, 91
O-FUEL-PUMP-EXRG4	1		C:	03, 09, 58, 91
O-FUEL-PUMP-MAIN1	1		C:	03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN2	1		C:	03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN3	1		C:	03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN4	1		C:	03, 09, 58, 63, 91
ON-GROUND	1	A15/27 DL	C:	03, 04, 09, 64, 91, 94
			S:	05, 06, 14, 26, 30, 38, 47, 55,
				56, 58, 63, 64, 65, 66, 68, 69, 74, 75
			P:	52, 82, 83, 84
P-RADAR-ALT-SW	1		C:	09, 22, 63, 91
R-CROSSFEED-SW	1		C:	03, 09, 44, 58, 91
R-LANDING-LIGHT-SW	1		C:	09, 11, 60, 68, 91 P: 72
R-SEPARATION-SW	1		C:	09, 44, 58, 91
REFUEL-AUX1-SW	1		C:	09, 44, 91
REFUEL-AUX2-SW	1		C:	09, 44, 91
REFUEL-AUX3-SW	1		C:	09, 44, 91
REFUEL-AUX4-SW	1		C:	09, 44, 91
REFUEL-EXRG1-SW	1		C:	09, 44, 91
REFUEL-EXRG2-SW	1		C:	09, 44, 91
REFUEL-EXRG3-SW	1		C:	09, 44, 91
REFUEL-EXRG4-SW	1		C:	09, 44, 91
TOTAL-FUEL-QTY	4	A08/13F	C:	09, 91

CHECKLIST 10 C.10

ENG1-A/I-SW	2	A04/20	C:	10, 25, 44, 57, 92
ENG2-A/I-SW	1	A04/21	C:	10, 25, 44, 57, 92
ENG3-A/I-SW	1	A04/22	C:	10, 25, 44, 57, 92
ENG4-A/I-SW	1	A04/23	C:	10, 25, 44, 57, 92
ENGINE-1-RUNNING	1		C:	10, 91 S: 03, 09, 14, 15, 17, 18
			P:	16, 20
ENGINE-2-RUNNING	1		C:	10 S: 03, 10, 22, 23, 24, 26
			P:	27, 28
ENGINE-3-RUNNING	1		C:	10 S: 03, 11, 30, 31, 33, 35
			P:	32, 36
ENGINE-4-RUNNING	1		C:	10 S: 03, 12, 38, 39, 41, 43
			P:	42, 45
ICE-ARMED-SW	1		C:	10, 25, 92
ICE-DETECTOR-SW	2		C:	10, 25, 26, 44
LANDING-GEAR-LEVER	1	A01/03	C:	10, 11, 12, 13, 14, 94 S: 55
			P:	59, 60, 61, 62, 67
PTU-1/2-SW	1		C:	10, 11, 25, 44, 59, 63, 92 S: 77
PTU-3/4-SW	1		C:	10, 11, 25, 44, 59, 63 S: 78
SYS1-BOOST-PRES-LOW-LT	1		C:	10, 92
SYS1-BOOST-PUMP-SW	1		C:	10, 11, 19, 21, 59, 63
SYS1-FLUID-EMPTY	1		C:	10
SYS2-BOOST-PRES-LOW-LT	1		C:	10, 92

SYS3-BOOST-PRES-LOW-LT	1		C: 10, 92
SYS4-BOOST-PUMP-SW	1		C: 10, 11, 19, 21, 59, 63
SYS4-BOT-PRES-LOW-LT	1		C: 10, 92
SYS4-FLUID-EMPTY	1		C: 10

CHECKLIST 11 C.11

L-LANDING-LIGHT-SW	1		C: 09, 11, 60, 68, 91 P: 53
LANDING-GEAR-LEVER	1	A01/03	C: 10, 11, 12, 13, 14, 94 S: 55
			P: 59, 60, 61, 62, 67
NOSE-LANDING-LIGHT-SW	1		C: 11, 60, 68 P: 70
PTU-1/2-SW	1		C: 10, 11, 25, 44, 59, 63, 92 S: 77
PTU-3/4-SW	1		C: 10, 11, 25, 44, 59, 63 S: 78
R-LANDING-LIGHT-SW	1		C: 09, 11, 60, 68, 91 P: 72
SYS1-BOOST-PUMP-SW	1		C: 10, 11, 19, 21, 59, 63
SYS4-BOOST-PUMP-SW	1		C: 10, 11, 19, 21, 59, 63

CHECKLIST 12 C.12

APU-GEN-SELECT-SW	2		C: 03, 12, 19, 21, 56, 92 S: 03, 04
APU/EXT-POWER-SW	2		C: 03, 12, 19, 21, 56, 92 S: 04
			P: 46
BATTERY-SELECT-SW	2		C: 12, 21
BRAKE-PRES-NORM	3		C: 12
BRAKE-SUPPLY-SELECT-SW	2		C: 12, 14, 22, 26, 45, 60, 63
C-PITOT-HEAT-SW	1		C: 04, 12, 63, 68
CONTINUOUS-IGNITION	1		C: 12, 45, 93
CSD1-DISCONNECT-SW	1		C: 12, 92 S: 03, 09
CSD2-DISCONNECT-SW	1		C: 12, 92 S: 03, 10
CSD3-DISCONNECT-SW	1		C: 12, 92 S: 03, 11
CSD4-DISCONNECT-SW	1		C: 12, 92 S: 03, 12
DCVM-SELECT-SW	2		C: 12 S: 13
ELEV-FEEL-SYS1-SW	1		C: 12
ELEV-FEEL-SYS4-SW	1		C: 12
ENG1-FUEL-&-START-IGN	2		C: 12, 45, 93 S: 19 P: 20
ENG2-FUEL-&-START-IGN	2		C: 12, 45, 93 S: 25 P: 28
ENG3-FUEL-&-START-IGN	2		C: 12, 45, 93 S: 34 P: 36
ENG4-FUEL-&-START-IGN	2		C: 12, 45, 93 S: 40 P: 45
EXT-POWER-LT	1		C: 12
FLIGHT-L-SYS-A-SW	1		C: 12
FLIGHT-L-SYS-B-SW	1		C: 12
FLIGHT-R-SYS-A-SW	1		C: 12
FLIGHT-R-SYS-B-SW	1		C: 12
GEN1-BUS-TIE-SW	2		C: 03, 12 P: 80
GEN1-SW	2		C: 03, 12 S: 03, 04 P: 48
GEN2-BUS-TIE-SW	2		C: 03, 12
GEN2-SW	2		C: 03, 12 S: 03, 04
GEN3-BUS-TIE-SW	2		C: 03, 12
GEN3-SW	2		C: 03, 12 S: 03, 04 P: 50
GEN4-SW	2		C: 03, 12 S: 03, 04 P: 51

GROUND-L-SYS-A-SW	1		C: 12	
GROUND-L-SYS-B-SW	1		C: 12	
GROUND-R-SYS-A-SW	1		C: 12	
GROUND-R-SYS-B-SW	1		C: 12	
GROUND-SPOILER-HANDLE	3	A08/01F*	C: 04, 12, 24, 61, 64	
INSTRUMENT-POWER-SW	2		C: 12, 45	
ISO-BUS-SW	1		C: 12	
L-AIL-SYS1-SW	1		C: 12, 62	
L-AIL-SYS2-SW	1		C: 12, 62	
L-AOA-VANE-HEATER-SW	1		C: 04, 12, 63, 68	
L-I-ELEV-SYS2-SW	1		C: 12, 61, 62	
L-I-ELEV-SYS3-SW	1		C: 12, 22, 59, 61, 62	
L-RATIO-SHIFTER-SW	2		C: 12	
L-RUDDER-SYS2-SW	1		C: 12, 62	
L-RUDDER-SYS3-SW	1		C: 12, 62	
LANDING-GEAR-LEVER	1	A01/03	C: 10, 11, 12, 13, 14, 94	S: 55
			P: 59, 60, 61, 62, 67	
MON-BUS2-OVRD-SW	1		C: 03, 12, 21, 56, 92	
MON-BUS3-OVRD-SW	1		C: 03, 12, 21, 56, 92	
O-ELEV-SYS1-SW	1		C: 12	
O-ELEV-SYS2-SW	1		C: 12	
O-ELEV-SYS3-SW	1		C: 12	
P-PITOT-HEAT-SW	1		C: 04, 12, 63, 68	
PACS-PITCH-SW	1		C: 12, 20, 61	
PACS-ROLL-SW	1		C: 12, 20, 61	
R-AIL-SYS2-SW	1		C: 12, 62	
R-AIL-SYS4-SW	1		C: 12, 62	
R-I-ELEV-SYS2-SW	1		C: 12, 22, 59, 61, 62	
R-I-ELEV-SYS3-SW	1		C: 12, 61, 62	
R-RATIO-SHIFTER-SW	2		C: 12	
RAT-SW	2		C: 04, 12, 24	
RUDDER-LIMITER	1		C: 12	
SLAT-DRIVE-SW	1		C: 12	
U-AOA-VANE-HEATER-SW	1		C: 04, 12, 63, 68	
U-RUDDER-SYS1-SW	1		C: 12, 62	
U-RUDDER-SYS3-SW	1		C: 12, 62	
UHF1-MODE-SW	2		C: 12, 22, 56	
UHF2-MODE-SW	2		C: 12, 22, 56	

CHECKLIST 13 C.13

A/C-WEIGHT	4		C: 13, 21	
CMA-MESSAGE	5		C: 13, 21	
LANDING-GEAR-LEVER	1	A01/03	C: 10, 11, 12, 13, 14, 94	S: 55
			P: 59, 60, 61, 62, 67	

CHECKLIST 14

C.14

AIRSPEED	3		C: 14, 64 S: 05, 47, 57, 69, 75
BRAKE-SUPPLY-SELECT-SW	2		C: 12, 14, 22, 26, 45, 60, 63
FLAP-HANDLE	3		C: 04, 14, 61 S: 05
FLAP-POS-IND	3	A18/29CF	C: 14, 22, 24, 26, 60, 68, 94 S: 05, 14, 26, 30, 38, 47 P: 82
LANDING-GEAR-LEVER	1	A01/03	C: 10, 11, 12, 13, 14, 94 S: 55 P: 59, 60, 61, 62, 67
XWIND-POS-CON	4		C: 04, 14, 59, 68

CHECKLIST 19

C.19

AIR-CONDITIONING-SW	2	A01/14	C: 19, 25, 57, 92
APU-GEN-SELECT-SW	2		C: 03, 12, 19, 21, 56, 92 S: 03, 04
APU/EXT-POWER-SW	2		C: 03, 12, 19, 21, 56, 92 S: 04 P: 46
EXT-ELECTRIC-POWER	1		C: 19, 21, 56 P: 46
LAPU-BLEED-AIR-SW	1		C: 03, 19, 21, 56, 57, 92 S: 54, 73
LAPU-CONT-SW	2		C: 03, 19, 21, 25, 56 S: 56
RAPU-BLEED-AIR-SW	1		C: 03, 19, 21 56, 57, 92
RAPU-CONT-SW	2		C: 03, 19, 21, 25, 56 S: 74
SYS1-ATM-PUMP-SW	1		C: 19, 21, 44, 59, 63, 92 S: 76
SYS1-BOOST-PUMP-SW	1		C: 10, 11, 19, 21, 59, 63
SYS1-BOT-SW	1		C: 19, 21, 25, 44, 92 S: 76
SYS1-TOP-SW	1		C: 19, 21, 25, 44 S: 76
SYS2-BOT-SW	1		C: 19, 21, 44, 92 S: 77
SYS2-TOP-SW	1		C: 19, 21, 44 S: 77
SYS3-BOT-SW	1		C: 19, 21, 44, 92 S: 78
SYS3-TOP-SW	1		C: 19, 21, 44 S: 78
SYS4-ATM-PUMP-SW	1		C: 19, 21, 44, 59, 63, 92 S: 79
SYS4-BOOST-PUMP-SW	1		C: 10, 11, 19, 21, 59, 63
SYS4-BOT-SW	1		C: 19, 21, 25, 44, 92 S: 79
SYS4-TOP-SW	1		C: 19, 21, 25, 44 S: 79

CHECKLIST 20

C.20

BRAKES-LT	1	C: 20, 22, 45, 60, 63
MASTER-POWER-ON-LATERAL	1	C: 20, 62
PACS-PITCH-SW	1	C: 12, 20, 61
PACS-ROLL-SW	1	C: 12, 20, 61
STALLIMITER1-OFF-LT	1	C: 20

CHECKLIST 21

C.21

A/C-WEIGHT	4		C: 13, 21
APU-GEN-SELECT-SW	2		C: 03, 12, 19, 21, 56, 92 S: 03, 04
APU/EXT-POWER-SW	2		C: 03, 12, 19, 21, 56, 92 S: 04 P: 46

BATTERY-SELECT-SW	2		C:	12, 21				
CMA-MESSAGE	5		C:	13, 21				
EXT-ELECTRIC-POWER	1		C:	19, 21, 56	P:	46		
FLOOR-HEAT-SW	2	A01/09	C:	09, 21, 44, 57, 59				
GEN-VOLTS-&-FREQ-SW	2	M01/03	C:	03, 21, 56, 92	S:	03, 04		
LAPU-BLEED-AIR-SW	1		C:	03, 19, 21, 56, 57, 92	S:	54, 73		
LAPU-CONT-SW	2		C:	03, 19, 21, 25, 56	S:	56		
LAPU-DOOR-OPEN-LT	1		C:	21, 56				
LAPU-ON-SPEED-LT	1		C:	03, 21	S:	03, 04, 56		
LAPU-START-LT	1		C:	21, 56				
MADAR-OPERATE	1		C:	21				
MADAR-POWER	1		C:	21				
MON-BUS2-OVRD-SW	1		C:	03, 12, 21, 56, 92				
MON-BUS3-OVRD-SW	1		C:	03, 12, 21, 56, 92				
RAPU-BLEED-AIR-SW	1		C:	03, 19, 21 56, 57, 92				
RAPU-CONT-SW	2		C:	03, 19, 21, 25, 56	S:	74		
RAPU-DOOR-OPEN-LT	1		C:	03, 21, 56				
RAPU-ON-SPEED-LT	1		C:	03, 21	S:	03, 04, 74		
RAPU-START-LT	1		C:	03, 21, 56				
SYS1-ATM-PUMP-PRESS-LT	1		C:	21, 44, 59				
SYS1-ATM-PUMP-SW	1		C:	19, 21, 44, 59, 63, 92	S:	76		
SYS1-ATM-START-SW	1		C:	21, 44, 59	S:	76		
SYS1-ATM-VALVE-OPEN-LT	1		C:	21, 44, 59				
SYS1-BOOST-PUMP-SW	1		C:	10, 11, 19, 21, 59, 63				
SYS1-BOT-SW	1		C:	19, 21, 25, 44, 92	S:	76		
SYS1-HYD-PRESSURE	3		C:	21, 25, 92	S:	76, 77		
SYS1-TOP-SW	1		C:	19, 21, 25, 44	S:	76		
SYS2-BOT-SW	1		C:	19, 21, 44, 92	S:	77		
SYS2-TOP-SW	1		C:	19, 21, 44	S:	77		
SYS3-BOT-SW	1		C:	19, 21, 44, 92	S:	78		
SYS3-TOP-SW	1		C:	19, 21, 44	S:	78		
SYS4-ATM-PUMP-PRESS-LT	1		C:	21, 44, 59				
SYS4-ATM-PUMP-SW	1		C:	19, 21, 44, 59, 63, 92	S:	79		
SYS4-ATM-START-SW	1		C:	21, 44, 59	S:	79		
SYS4-ATM-VALVE-OPEN-LT	1		C:	21, 44, 59				
SYS4-BOOST-PUMP-SW	1		C:	10, 11, 19, 21, 59, 63				
SYS4-BOT-SW	1		C:	19, 21, 25, 44, 92	S:	79		
SYS4-HYD-PRESSURE	3		C:	21, 25, 92	S:	78, 79		
SYS4-TOP-SW	1		C:	19, 21, 25, 44	S:	79		
WW-ISO-VALVE-OPEN-LT	1		C:	21				

CHECKLIST 22 C.22

BRAKE-SUPPLY-SELECT-SW	2		C:	12, 14, 22, 26, 45, 60, 63				
BRAKES-LT	1		C:	20, 22, 45, 60, 63				
C-RADAR-ALT-SW	1		C:	22				
FLAP-POS-IND	3	A18/29CF	C:	14, 22, 24, 26, 60, 68, 94				
			S:	05, 14, 26, 30, 38, 47	P:	82		
L-I-ELEV-SYS3-SW	1		C:	12, 22, 59, 61, 62				
LATERAL-AUG-SW	1	A17/07	C:	22, 26, 45				
P-RADAR-ALT-SW	1		C:	09, 22, 63, 91				

PITCH-AUG-SW	1	A17/27	C: 22, 26, 45
R-I-ELEV-SYS2-SW	1		C: 12, 22, 59, 61, 62
SKID-CONTROL-SW	2		C: 04, 22, 60, 68, 94
THROTTLE1	3	A01/30C	C: 22, 64, 68, 93, 94 S: 14, 58, 71
THROTTLE2	3	A01/29C	D C: 22, 64, 68, 93, 94 S: 26, 58, 71
THROTTLE3	3	A01/26C	D C: 22, 64, 68, 93, 94 S: 30
THROTTLE4	3	A01/25C	C: 22, 64, 68, 93, 94 S: 38
UHF1-MODE-SW	2		C: 12, 22, 56
UHF2-MODE-SW	2		C: 12, 22, 56
YAW-AUG-SW	1	A17/15	C: 22, 26, 45

CHECKLIST 23 C.23

CABIN-PRES-MODE-SW	2		C: 23, 57, 95
FUEL-TEMP-SELECT-SW	2		C: 23
LAPU-ISO-SW	1		C: 03, 23, 57
RAPU-ISO-SW	1		C: 03, 23, 57

CHECKLIST 24 C.24

ALDCS-SW	1	A14/10	C: 04, 24, 62
FLAP-POS-IND	3	A18/29CF	C: 14, 22, 24, 26, 60, 68, 94 S: 05, 14, 26, 30, 38, 47 P: 82
GROUND-SPOILER-HANDLE	3	A08/01F*	C: 04, 12, 24, 61, 64
L-AIL-TRIM-IND	4		C: 24, 61
PITCH-TRIM-IND	4		C: 24, 61
R-AIL-TRIM-IND	4		C: 24, 61
RAT-SW	2		C: 04, 12, 24
RUDDER-LIMIT-SW	1		C: 04, 24
RUDDER-PEDAL	4		C: 24, 61
RUDDER-TRIM-IND	4		C: 24
SLAT-POS-IND	1		C: 24, 68

CHECKLIST 25 C.25

AIR-CONDITIONING-SW	2	A01/14	C: 19, 25, 57, 92
ENG1-A/I-SW	2	A04/20	C: 10, 25, 44, 57, 92
ENG2-A/I-SW	1	A04/21	C: 10, 25, 44, 57, 92
ENG3-A/I-SW	1	A04/22	C: 10, 25, 44, 57, 92
ENG4-A/I-SW	1	A04/23	C: 10, 25, 44, 57, 92
ICE-ARMED-SW	1		C: 10, 25, 92
ICE-DETECT-TEST-SW	1		C: 25
ICE-DETECTOR-SW	2		C: 10, 25, 26, 44
LAPU-CONT-SW	2		C: 03, 19, 21, 25, 56 S: 56
PTU-1/2-SW	1		C: 10, 11, 25, 44, 59, 63, 92 S: 77
PTU-3/4-SW	1		C: 10, 11, 25, 44, 59, 63 S: 78
RAPU-CONT-SW	2		C: 03, 19, 21, 25, 56 S: 74

RECIRC-FAN-SW	1		C: 25, 44, 57
SYS1-BOT-SW	1		C: 19, 21, 25, 44, 92 S: 76
SYS1-HYD-PRESSURE	3		C: 21, 25, 92 S: 76, 77
SYS1-TOP-SW	1		C: 19, 21, 25, 44 S: 76
SYS4-BOT-SW	1		C: 19, 21, 25, 44, 92 S: 79
SYS4-HYD-PRESSURE	3		C: 21, 25, 92 S: 78, 79
SYS4-TOP-SW	1		C: 19, 21, 25, 44 S: 79

CHECKLIST 26 C.26

BRAKE-SUPPLY-SELECT-SW	2		C: 12, 14, 22, 26, 45, 60, 63
FLAP-POS-IND	3	A18/29CF	C: 14, 22, 24, 26, 60, 68, 94
			S: 05, 14, 26, 30, 38, 47 P: 82
ICE-DETECTOR-SW	2		C: 10, 25, 26, 44
LATERAL-AUG-SW	1	A17/07	C: 22, 26, 45
PITCH-AUG-SW	1	A17/27	C: 22, 26, 45
YAW-AUG-SW	1	A17/15	C: 22, 26, 45

CHECKLIST 44 C.44

AUTO-REFUEL-SW	1		C: 09, 44
C-SEPARATION-SW	1		C: 44, 58
ENG1-A/I-SW	2	A04/20	C: 10, 25, 44, 57, 92
ENG1-AUG-AIR-SW	1		C: 44, 57, 92
ENG2-A/I-SW	1	A04/21	C: 10, 25, 44, 57, 92
ENG2-AUG-AIR-SW	1		C: 44, 57, 92
ENG3-A/I-SW	1	A04/22	C: 10, 25, 44, 57, 92
ENG3-AUG-AIR-SW	1		C: 44, 57, 92
ENG4-A/I-SW	1	A04/23	C: 10, 25, 44, 57, 92
ENG4-AUG-AIR-SW	1		C: 44, 57, 92
FILL-MAIN1-SW	1		C: 09, 44, 91
FILL-MAIN2-SW	1		C: 09, 44, 91
FILL-MAIN3-SW	1		C: 09, 44, 91
FILL-MAIN4-SW	1		C: 09, 44, 91
FLOOR-HEAT-SW	2	A01/09	C: 09, 21, 44, 57, 59
FUEL-ISO-VALVE-1-SW	1		C: 44, 58
FUEL-ISO-VALVE-2-SW	1		C: 44, 58
FUEL-ISO-VALVE-3-SW	1		C: 44, 58
FUEL-ISO-VALVE-4-SW	1		C: 44, 58
ICE-DETECTOR-SW	2		C: 10, 25, 26, 44
KEYSET	5		C: 44, 63
L-CROSSFEED-SW	1		C: 03, 09, 44, 58, 91
L-SEPARATION-SW	1		C: 09, 44, 58, 91
PTU-1/2-SW	1		C: 10, 11, 25, 44, 59, 63, 92 S: 77
PTU-2/3-SW	1		C: 44, 59, 63, 92 S: 77, 78
PTU-3/4-SW	1		C: 10, 11, 25, 44, 59, 63 S: 78
R-CROSSFEED-SW	1		C: 03, 09, 44, 58, 91
R-SEPARATION-SW	1		C: 09, 44, 58, 91
RECIRC-FAN-SW	1		C: 25, 44, 57
REFUEL-AUX1-SW	1		C: 09, 44, 91

REFUEL-AUX2-SW	1		C:	09,	44,	91				
REFUEL-AUX3-SW	1		C:	09,	44,	91				
REFUEL-AUX4-SW	1		C:	09,	44,	91				
REFUEL-EXRG1-SW	1		C:	09,	44,	91				
REFUEL-EXRG2-SW	1		C:	09,	44,	91				
REFUEL-EXRG3-SW	1		C:	09,	44,	91				
REFUEL-EXRG4-SW	1		C:	09,	44,	91				
SYS1-ATM-PUMP-PRESS-LT	1		C:	21,	44,	59				
SYS1-ATM-PUMP-SW	1		C:	19,	21,	44,	59,	63,	92	S: 76
SYS1-ATM-START-SW	1		C:	21,	44,	59	S:	76		
SYS1-ATM-VALVE-OPEN-LT	1		C:	21,	44,	59				
SYS1-BOT-SW	1		C:	19,	21,	25,	44,	92	S:	76
SYS1-TOP-SW	1		C:	19,	21,	25,	44	S:	76	
SYS2-BOT-SW	1		C:	19,	21,	44,	92	S:	77	
SYS2-TOP-SW	1		C:	19,	21,	44	S:	77		
SYS3-BOT-SW	1		C:	19,	21,	44,	92	S:	78	
SYS3-TOP-SW	1		C:	19,	21,	44	S:	78		
SYS4-ATM-PUMP-PRESS-LT	1		C:	21,	44,	59				
SYS4-ATM-PUMP-SW	1		C:	19,	21,	44,	59,	63,	92	S: 79
SYS4-ATM-START-SW	1		C:	21,	44,	59	S:	79		
SYS4-ATM-VALVE-OPEN-LT	1		C:	21,	44,	59				
SYS4-BOT-SW	1		C:	19,	21,	25,	44,	92	S:	79
SYS4-TOP-SW	1		C:	19,	21,	25,	44	S:	79	

CHECKLIST 45 C.45

BRAKE-SUPPLY-SELECT-SW	2		C:	12,	14,	22,	26,	45,	60,	63
BRAKES-LT	1		C:	20,	22,	45,	60,	63		
CONTINUOUS-IGNITION	1		C:	12,	45,	93				
ENG1-FUEL-&-START-IGN	2		C:	12,	45,	93	S:	19	P:	20
ENG2-FUEL-&-START-IGN	2		C:	12,	45,	93	S:	25	P:	28
ENG3-FUEL-&-START-IGN	2		C:	12,	45,	93	S:	34	P:	36
ENG4-FUEL-&-START-IGN	2		C:	12,	45,	93	S:	40	P:	45
INS1-MSU-MODE-SW	2		C:	45,	59					
INS2-MSU-MODE-SW	2		C:	45,	59					
INS3-MSU-MODE-SW	2		C:	45,	59					
INSTRUMENT-POWER-SW	2		C:	12,	45					
LATERAL-AUG-SW	1	A17/07	C:	22,	26,	45				
PITCH-AUG-SW	1	A17/27	C:	22,	26,	45				
YAW-AUG-SW	1	A17/15	C:	22,	26,	45				

CHECKLIST 56 C.56

APU-GEN-SELECT-SW	2		C:	03,	12,	19,	21,	56,	92	S: 03, 04
APU/EXT-POWER-SW	2		C:	03,	12,	19,	21,	56,	92	S: 04
			P:	46						
ENG-&-APU-FIRE-DET-SW	2		C:	56						
EXT-ELECTRIC-POWER	1		C:	19,	21,	56	P:	46		
GEN-VOLTS-&-FREQ-SW	2	M01/03	C:	03,	21,	56,	92	S:	03, 04	
LAPU-BLEED-AIR-SW	1		C:	03,	19,	21,	56,	57,	92	S: 54, 73

LAPU-CONT-SW	2		C: 03, 19, 21, 25, 56 S: 56
LAPU-DOOR-OPEN-LT	1		C: 21, 56
LAPU-FIRE-HANDLE	1		C: 56
LAPU-START-LT	1		C: 21, 56
MAIN-BUS1-AFT-OFF-LT	1		C: 56
MAIN-BUS1-FWD-OFF-LT	1		C: 56
MAIN-BUS2-AFT-OFF-LT	1		C: 56
MAIN-BUS2-FWD-OFF-LT	1		C: 56
MAIN-BUS3-AFT-OFF-LT	1		C: 56
MAIN-BUS3-FWD-OFF-LT	1		C: 56
MAIN-BUS4-AFT-OFF-LT	1		C: 56
MAIN-BUS4-FWD-OFF-LT	1		C: 56
MON-BUS2-OVRD-SW	1		C: 03, 12, 21, 56, 92
MON-BUS3-OVRD-SW	1		C: 03, 12, 21, 56, 92
PHASE-SELECT-SW	2		C: 03, 56
RAPU-BLEED-AIR-SW	1		C: 03, 19, 21 56, 57, 92
RAPU-CONT-SW	2		C: 03, 19, 21, 25, 56 S: 74
RAPU-DOOR-OPEN-LT	1		C: 03, 21, 56
RAPU-FIRE-HANDLE	1		C: 56
RAPU-START-LT	1		C: 03, 21, 56
SHORT-DISC-SW	1		C: 56
UHF1-MODE-SW	2		C: 12, 22, 56
UHF2-MODE-SW	2		C: 12, 22, 56

CHECKLIST 57 C.57

25-L-OXYGEN-QTY-IND	3		C: 57 S: 01
25-L-OXYGEN-QTY-LOW-LT	1		C: 57
25-L-OXYGEN-QTY-TEST-SW	1		C: 57
75-L-OXYGEN-QTY-IND	3		C: 57 S: 02
75-L-OXYGEN-QTY-LOW-LT	1		C: 57
75-L-OXYGEN-QTY-TEST-SW	1		C: 57
AERIAL-REF-BOOM-LATCH-SW	1		C: 57
AERIAL-REFUEL-DOORS-SW	1		C: 57
AERIAL-REFUEL-ELEC-PWR	1		C: 57
AIR-CONDITIONING-SW	2	A01/14	C: 19, 25, 57, 92
AIRFLOW-SW	2		C: 57
AVIONICS-FAN-SW	1		C: 57
C-DUCT-OVERHEAT-LT	1		C: 57
CABIN-PRES-MODE-SW	2		C: 23, 57, 95
CABIN-ROC-CON	3		C: 57
CARGO-SW	2	A03/28	C: 57
EMER-DEPRESS-SW	1		C: 57
ENG1-A/I-SW	2	A04/20	C: 10, 25, 44, 57, 92
ENG1-AUG-AIR-SW	1		C: 44, 57, 92
ENG1-BLEED-AIR-SW	1	A04/16	C: 57, 92 S: 54
ENG2-A/I-SW	1	A04/21	C: 10, 25, 44, 57, 92
ENG2-AUG-AIR-SW	1		C: 44, 57, 92
ENG2-BLEED-AIR-SW	1	A04/17	C: 57, 92 S: 54
ENG3-A/I-SW	1	A04/22	C: 10, 25, 44, 57, 92
ENG3-AUG-AIR-SW	1		C: 44, 57, 92

ENG3-BLEED-AIR-SW	1	A04/18	C: 57, 92	S: 73
ENG4-A/I-SW	1	A04/23	C: 10, 25, 44, 57, 92	
ENG4-AUG-AIR-SW	1		C: 44, 57, 92	
ENG4-BLEED-AIR-SW	1	A04/19	C: 57, 92	S: 73
FLIGHT-STA-SW	2	A03/16	C: 57	
FLOOR-HEAT-SW	2	A01/09	C: 09, 21, 44, 57, 59	
KNEEL-COMMAND-SW	2		C: 57	
KNEEL-SELECT-SW	2		C: 57	
L-AERIAL-REFUEL-SW	1		C: 57	
L-DUCT-OVERHEAT-SW	2		C: 57	
L-FLOW-CONTROL-SW	1	A05/04	C: 57	
L-WING-ISO-SW	1		C: 57	
LAPU-BLEED-AIR-SW	1		C: 03, 19, 21, 56, 57, 92	S: 54, 73
LAPU-ISO-SW	1		C: 03, 23, 57	
LAPU-ISO-VALVE-OPEN-LT	1		C: 57	
MANUAL-CABIN-PRES	3		C: 57	
R-AERIAL-REFUEL-SW	1		C: 57	
R-DUCT-OVERHEAT-SW	2		C: 57	
R-FLOW-CONTROL-SW	1	A10/30	C: 57	
R-WING-ISO-SW	1		C: 57	
RAPU-BLEED-AIR-SW	1		C: 03, 19, 21 56, 57, 92	
RAPU-ISO-SW	1		C: 03, 23, 57	
RAPU-ISO-VALVE-OPEN-LT	1		C: 57	
RECIRC-FAN-SW	1		C: 25, 44, 57	
RELIEF-CREW-SW	2	A03/20	C: 57	
TROOP-CMPT-SW	2	A03/24	C: 57	

CHECKLIST 58

C.58

C-SEPARATION-SW	1		C: 44, 58
ENG1-FUEL-HEATER-SW	1	A04/15	C: 58
ENG2-FUEL-HEATER-SW	1	A04/11	C: 58
ENG3-FUEL-HEATER-SW	1	A04/07	C: 58
ENG4-FUEL-HEATER-SW	1	A04/03	C: 58
FUEL-ISO-VALVE-1-SW	1		C: 44, 58
FUEL-ISO-VALVE-2-SW	1		C: 44, 58
FUEL-ISO-VALVE-3-SW	1		C: 44, 58
FUEL-ISO-VALVE-4-SW	1		C: 44, 58
FUEL-QTY-IND-EXRG1	4		C: 58
FUEL-QTY-IND-EXRG2	4		C: 58
FUEL-QTY-IND-EXRG3	4		C: 58
FUEL-QTY-IND-EXRG4	4		C: 58
FUEL-QTY-TEST-AUX1	1		C: 58
FUEL-QTY-TEST-AUX2	1		C: 58
FUEL-QTY-TEST-AUX3	1		C: 58
FUEL-QTY-TEST-AUX4	1		C: 58
FUEL-QTY-TEST-EXRG1	1		C: 58
FUEL-QTY-TEST-EXRG2	1		C: 58
FUEL-QTY-TEST-EXRG3	1		C: 58
FUEL-QTY-TEST-EXRG4	1		C: 58
FUEL-QTY-TEST-MAIN1	1		C: 58

FUEL-QTY-TEST-MAIN2	1	C:	58
FUEL-QTY-TEST-MAIN3	1	C:	58
FUEL-QTY-TEST-MAIN4	1	C:	58
I-FUEL-PUMP-AUX1	1	C:	03, 58, 91
I-FUEL-PUMP-AUX2	1	C:	03, 58, 91
I-FUEL-PUMP-AUX3	1	C:	03, 58, 91
I-FUEL-PUMP-AUX4	1	C:	03, 58, 91
I-FUEL-PUMP-EXRG1	1	C:	03, 09, 58, 91
I-FUEL-PUMP-EXRG2	1	C:	03, 09, 58, 91
I-FUEL-PUMP-EXRG3	1	C:	03, 09, 58, 91
I-FUEL-PUMP-EXRG4	1	C:	03, 09, 58, 91
I-FUEL-PUMP-MAIN1	1	C:	03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN2	1	C:	03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN3	1	C:	03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN4	1	C:	03, 09, 58, 63, 91
L-CROSSFEED-SW	1	C:	03, 09, 44, 58, 91
L-FUEL-JETT-SW	1	C:	58
L-GROUND-REFUEL-SW	2	C:	58
L-SEPARATION-SW	1	C:	09, 44, 58, 91
MAIN1-SUMP-LOW-TEST-SW	2	C:	58
MAIN4-SUMP-LOW-TEST-SW	2	C:	58
O-FUEL-PUMP-AUX1	1	C:	03, 09, 58, 91
O-FUEL-PUMP-AUX2	1	C:	03, 09, 58, 91
O-FUEL-PUMP-AUX3	1	C:	03, 09, 58, 91
O-FUEL-PUMP-AUX4	1	C:	03, 09, 58, 91
O-FUEL-PUMP-EXRG1	1	C:	03, 09, 58, 91
O-FUEL-PUMP-EXRG2	1	C:	03, 09, 58, 91
O-FUEL-PUMP-EXRG3	1	C:	03, 09, 58, 91
O-FUEL-PUMP-EXRG4	1	C:	03, 09, 58, 91
O-FUEL-PUMP-MAIN1	1	C:	03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN2	1	C:	03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN3	1	C:	03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN4	1	C:	03, 09, 58, 63, 91
PRE-CHECK-SW	2	C:	58
R-CROSSFEED-SW	1	C:	03, 09, 44, 58, 91
R-FUEL-JETT-SW	1	C:	58
R-GROUND-REFUEL-SW	2	C:	58
R-SEPARATION-SW	1	C:	09, 44, 58, 91

CHECKLIST 59 C.59

AVIONICS-ZONE-WARN	1	C:	59
ENG1-FIRE-HANDLE	1	C:	59
ENG2-FIRE-HANDLE	1	C:	59
ENG2-REV-TH-EMER-RET-SW	1	C:	59
ENG3-FIRE-HANDLE	1	C:	59
ENG3-REV-TH-EMER-RET-SW	1	C:	59
ENG4-FIRE-HANDLE	1	C:	59
FLOOR-HEAT-SW	2 A01/09	C:	09, 21, 44, 57, 59
FSS-ARM-SW	1	C:	59
HORN-SW	2	C:	59

INS1-MSU-MODE-SW	2	C: 45, 59	
INS2-MSU-MODE-SW	2	C: 45, 59	
INS3-MSU-MODE-SW	2	C: 45, 59	
L-I-ELEV-SYS3-SW	1	C: 12, 22, 59, 61, 62	
L-I-WING-DIS-SW	1	C: 59	
L-MAIN-WW-DIS-SW	1	C: 59	
L-O-WING-DIS-SW	1	C: 59	
L-PTU-DIS-SW	1	C: 59	
L-WING-VENT-OPEN	1	C: 59	
L-WING-VENT-SW	1	C: 59	
MLG-CASTER-SW	1	C: 59, 68	
NFS-TEST-SW	2	C: 59	
NLG-STEERING-SW	1	C: 59	
NOSE-WHEEL-WELL-DIS-SW	1	C: 59	
PTU-1/2-SW	1	C: 10, 11, 25, 44, 59, 63, 92	S: 77
PTU-2/3-SW	1	C: 44, 59, 63, 92	S: 77, 78
PTU-3/4-SW	1	C: 10, 11, 25, 44, 59, 63	S: 78
R-I-ELEV-SYS2-SW	1	C: 12, 22, 59, 61, 62	
R-I-WING-DIS-SW	1	C: 59	
R-MAIN-WW-DIS-SW	1	C: 59	
R-O-WING-DIS-SW	1	C: 59	
R-PTU-DIS-SW	1	C: 59	
R-WING-VENT-OPEN	1	C: 59	
R-WING-VENT-SW	1	C: 59	
SYS1-ATM-PUMP-PRESS-LT	1	C: 21, 44, 59	
SYS1-ATM-PUMP-SW	1	C: 19, 21, 44, 59, 63, 92	S: 76
SYS1-ATM-START-SW	1	C: 21, 44, 59	S: 76
SYS1-ATM-VALVE-OPEN-LT	1	C: 21, 44, 59	
SYS1-BOOST-PUMP-SW	1	C: 10, 11, 19, 21, 59, 63	
SYS4-ATM-PUMP-PRESS-LT	1	C: 21, 44, 59	
SYS4-ATM-PUMP-SW	1	C: 19, 21, 44, 59, 63, 92	S: 79
SYS4-ATM-START-SW	1	C: 21, 44, 59	S: 79
SYS4-ATM-VALVE-OPEN-LT	1	C: 21, 44, 59	
SYS4-BOOST-PUMP-SW	1	C: 10, 11, 19, 21, 59, 63	
UNDERFLOOR-AFT-DIS-SW	1	C: 59	
UNDERFLOOR-FWD-DIS-SW	1	C: 59	
UNDERFLOOR-MID-DIS-SW	1	C: 59	
XWIND-POS-CON	4	C: 04, 14, 59, 68	
XWIND-SW	1	C: 59	

CHECKLIST 60 C.60

BRAKE-SUPPLY-SELECT-SW	2		C: 12, 14, 22, 26, 45, 60, 63	
BRAKES-LT	1		C: 20, 22, 45, 60, 63	
FLAP-POS-IND	3	A18/29CF	C: 14, 22, 24, 26, 60, 68, 94	
			S: 05, 14, 26, 30, 38, 47	P: 82
L-LANDING-LIGHT-SW	1		C: 09, 11, 60, 68, 91	P: 53
NOSE-LANDING-LIGHT-SW	1		C: 11, 60, 68	P: 70
R-LANDING-LIGHT-SW	1		C: 09, 11, 60, 68, 91	P: 72

SKID-CONTROL-SW	2		C: 04, 22, 60, 68, 94
SKID-CONTROL-TEST-1-SW	1		C: 60
SKID-CONTROL-TEST-2-SW	1		C: 60
SKID-CONTROL-TEST-3-SW	1		C: 60

CHECKLIST 61 C.61

A-PITCH-TRIM-GROUND-SW	2		C: 61
A-PITCH-TRIM-POWER-SW	2		C: 61
A-TRIM-TEST-SW	2		C: 61
COLUMN-POS-CMD	4		C: 61
FLAP-HANDLE	3		C: 04, 14, 61 S: 05
GROUND-SPOILER-HANDLE	3	A08/01F*	C: 04, 12, 24, 61, 64
L-AIL-TRIM-IND	4		C: 24, 61
L-I-ELEV-SYS2-SW	1		C: 12, 61, 62
L-I-ELEV-SYS3-SW	1		C: 12, 22, 59, 61, 62
P-ROLL-HUB-FORCE	3		DEHAL C: 61
PACS-PITCH-SW	1		C: 12, 20, 61
PACS-ROLL-SW	1		C: 12, 20, 61
PITCH-P-HUB-FORCE	3		DEHAL C: 61
PITCH-TRIM-GROUND-SW	2		C: 61, 62
PITCH-TRIM-IND	4		C: 24, 61
PITCH-TRIM-MANUAL-LEVER	3		C: 61
PITCH-TRIM-MANUAL-SW	1		C: 61
PITCH-TRIM-POWER-SW	2		C: 61, 62
R-AIL-TRIM-IND	4		C: 24, 61
R-I-ELEV-SYS2-SW	1		C: 12, 22, 59, 61, 62
R-I-ELEV-SYS3-SW	1		C: 12, 61, 62
RUDDER-PEDAL	4		C: 24, 61
RUDDER-TRIM-GROUND-SW	1		C: 61
RUDDER-TRIM-POWER-SW	2		C: 61

CHECKLIST 62 C.62

A/P-ALT-HOLD-SW	1		C: 62
A/P-DISC-SW	1		C: 62
A/P-PITCH-OFF-LT	1		C: 62
A/P-PITCH-WHEEL	3		C: 62
A/P-ROLL-OFF-LT	1		C: 62
A/P-TURN	3		C: 62
AFCS-RESET/FAIL-BUTTON	1		C: 62
AFCS-TEST-LT	1		C: 62
ALDCS-SW	1	A14/10	C: 04, 24, 62
C-ROLL-HUB-FORCE	3		DEHAL C: 62
L-AIL-SYS1-SW	1		C: 12, 62
L-AIL-SYS2-SW	1		C: 12, 62
L-I-ELEV-SYS2-SW	1		C: 12, 61, 62
L-I-ELEV-SYS3-SW	1		C: 12, 22, 59, 61, 62
L-RUDDER-SYS2-SW	1		C: 12, 62
L-RUDDER-SYS3-SW	1		C: 12, 62

LATERAL-AUG-OFF-LT	1	C: 62
MASTER-POWER-ON-LATERAL	1	C: 20, 62
MASTER-POWER-ON-PITCH	1	C: 62
P-CADC-SW	2	C: 62
PITCH-AUG-OFF-LT	1	C: 62
PITCH-C-HUB-FORCE	3	DEHAL C: 62
PITCH-TRIM-GROUND-SW	2	C: 61, 62
PITCH-TRIM-POWER-SW	2	C: 61, 62
R-AIL-SYS2-SW	1	C: 12, 62
R-AIL-SYS4-SW	1	C: 12, 62
R-I-ELEV-SYS2-SW	1	C: 12, 22, 59, 61, 62
R-I-ELEV-SYS3-SW	1	C: 12, 61, 62
U-RUDDER-SYS1-SW	1	C: 12, 62
U-RUDDER-SYS3-SW	1	C: 12, 62
YAW-AUG-MANUAL-TRIM	4	C: 62
YAW-AUG-OFF-LT	1	C: 62

CHECKLIST 63 C.63

A-MLG-SPIN-TEST-SW	2	C: 63
BAILOUT-ALARM-SW	1	C: 63
BRAKE-SUPPLY-SELECT-SW	2	C: 12, 14, 22, 26, 45, 60, 63
BRAKES-LT	1	C: 20, 22, 45, 60, 63
C-CADC-SW	2	C: 63
C-PITOT-HEAT-SW	1	C: 04, 12, 63, 68
F-MLG-SPIN-TEST-SW	2	C: 63
I-FUEL-PUMP-MAIN1	1	C: 03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN2	1	C: 03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN3	1	C: 03, 09, 58, 63, 91
I-FUEL-PUMP-MAIN4	1	C: 03, 09, 58, 63, 91
KEYSET	5	C: 44, 63
L-AOA-VANE-HEATER-SW	1	C: 04, 12, 63, 68
O-FUEL-PUMP-MAIN1	1	C: 03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN2	1	C: 03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN3	1	C: 03, 09, 58, 63, 91
O-FUEL-PUMP-MAIN4	1	C: 03, 09, 58, 63, 91
P-PITOT-HEAT-SW	1	C: 04, 12, 63, 68
P-RADAR-ALT-SW	1	C: 09, 22, 63, 91
PTU-1/2-SW	1	C: 10, 11, 25, 44, 59, 63, 92 S: 77
PTU-2/3-SW	1	C: 44, 59, 63, 92 S: 77, 78
PTU-3/4-SW	1	C: 10, 11, 25, 44, 59, 63 S: 78
SYS1-ATM-PUMP-SW	1	C: 19, 21, 44, 59, 63, 92 S: 76
SYS1-BOOST-PUMP-SW	1	C: 10, 11, 19, 21, 59, 63
SYS4-ATM-PUMP-SW	1	C: 19, 21, 44, 59, 63, 92 S: 79
SYS4-BOOST-PUMP-SW	1	C: 10, 11, 19, 21, 59, 63
U-AOA-VANE-HEATER-SW	1	C: 04, 12, 63, 68

CHECKLIST 64 C.64

AIRSPEED	3		C: 14, 64 S: 05, 47, 57, 69, 75
ALTITUDE-AGL	3		C: 09, 64, 91, 94 S: 05, 07, 08, 47, 71, 75
GROUND-SPOILER-HANDLE	3	A08/01F*	C: 04, 12, 24, 61, 64
MLG-ON-GROUND	1		C: 64
NLG-ON-GROUND	1		C: 64
ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84
THROTTLE1	3	A01/30C	C: 22, 64, 68, 93, 94 S: 14, 58, 71
THROTTLE2	3	A01/29C	D C: 22, 64, 68, 93, 94 S: 26, 58, 71
THROTTLE3	3	A01/26C	D C: 22, 64, 68, 93, 94 S: 30
THROTTLE4	3	A01/25C	C: 22, 64, 68, 93, 94 S: 38

CHECKLIST 68 C.68

C-PITOT-HEAT-SW	1		C: 04, 12, 63, 68
FLAP-POS-IND	3	A18/29CF	C: 14, 22, 24, 26, 60, 68, 94 S: 05, 14, 26, 30, 38, 47 P: 82
L-AOA-VANE-HEATER-SW	1		C: 04, 12, 63, 68
L-LANDING-LIGHT-SW	1		C: 09, 11, 60, 68, 91 P: 53
MLG-CASTER-SW	1		C: 59, 68
MLG-POS-IND-L-A	4		C: 68 S: 63
MLG-POS-IND-L-F	4		C: 68 S: 64
MLG-POS-IND-R-A	4		C: 68 S: 65
MLG-POS-IND-R-F	4		C: 68 S: 66
NLG-POS-XWIND-IND	4		C: 68 S: 68
NOSE-LANDING-LIGHT-SW	1		C: 11, 60, 68 P: 70
P-PITOT-HEAT-SW	1		C: 04, 12, 63, 68
R-LANDING-LIGHT-SW	1		C: 09, 11, 60, 68, 91 P: 72
SKID-CONTROL-SW	2		C: 04, 22, 60, 68, 94
SLAT-POS-IND	1		C: 24, 68
THROTTLE1	3	A01/30C	C: 22, 64, 68, 93, 94 S: 14, 58, 71
THROTTLE2	3	A01/29C	D C: 22, 64, 68, 93, 94 S: 26, 58, 71
THROTTLE3	3	A01/26C	D C: 22, 64, 68, 93, 94 S: 30
THROTTLE4	3	A01/25C	C: 22, 64, 68, 93, 94 S: 38
U-AOA-VANE-HEATER-SW	1		C: 04, 12, 63, 68
XWIND-POS-CON	4		C: 04, 14, 59, 68

CHECKLIST 91 C.91

ALTITUDE-AGL	3		C: 09, 64, 91, 94 S: 05, 07, 08, 47, 71, 75
ENGINE-1-RUNNING	1		C: 10, 91 S: 03, 09, 14, 15, 17, 18 P: 16, 20

FILL-MAIN1-SW	1			C: 09, 44, 91	
FILL-MAIN2-SW	1			C: 09, 44, 91	
FILL-MAIN3-SW	1			C: 09, 44, 91	
FILL-MAIN4-SW	1			C: 09, 44, 91	
I-FUEL-PUMP-AUX1	1			C: 03, 58, 91	
I-FUEL-PUMP-AUX2	1			C: 03, 58, 91	
I-FUEL-PUMP-AUX3	1			C: 03, 58, 91	
I-FUEL-PUMP-AUX4	1			C: 03, 58, 91	
I-FUEL-PUMP-EXRG1	1			C: 03, 09, 58, 91	
I-FUEL-PUMP-EXRG2	1			C: 03, 09, 58, 91	
I-FUEL-PUMP-EXRG3	1			C: 03, 09, 58, 91	
I-FUEL-PUMP-EXRG4	1			C: 03, 09, 58, 91	
I-FUEL-PUMP-MAIN1	1			C: 03, 09, 58, 63, 91	
I-FUEL-PUMP-MAIN2	1			C: 03, 09, 58, 63, 91	
I-FUEL-PUMP-MAIN3	1			C: 03, 09, 58, 63, 91	
I-FUEL-PUMP-MAIN4	1			C: 03, 09, 58, 63, 91	
L-CROSSFEED-SW	1			C: 03, 09, 44, 58, 91	
L-LANDING-LIGHT-SW	1			C: 09, 11, 60, 68, 91	P: 53
L-SEPARATION-SW	1			C: 09, 44, 58, 91	
O-FUEL-PUMP-AUX1	1			C: 03, 09, 58, 91	
O-FUEL-PUMP-AUX2	1			C: 03, 09, 58, 91	
O-FUEL-PUMP-AUX3	1			C: 03, 09, 58, 91	
O-FUEL-PUMP-AUX4	1			C: 03, 09, 58, 91	
O-FUEL-PUMP-EXRG1	1			C: 03, 09, 58, 91	
O-FUEL-PUMP-EXRG2	1			C: 03, 09, 58, 91	
O-FUEL-PUMP-EXRG3	1			C: 03, 09, 58, 91	
O-FUEL-PUMP-EXRG4	1			C: 03, 09, 58, 91	
O-FUEL-PUMP-MAIN1	1			C: 03, 09, 58, 63, 91	
O-FUEL-PUMP-MAIN2	1			C: 03, 09, 58, 63, 91	
O-FUEL-PUMP-MAIN3	1			C: 03, 09, 58, 63, 91	
O-FUEL-PUMP-MAIN4	1			C: 03, 09, 58, 63, 91	
ON-GROUND	1	A15/27	DL	C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84	
P-RADAR-ALT-SW	1			C: 09, 22, 63, 91	
R-CROSSFEED-SW	1			C: 03, 09, 44, 58, 91	
R-LANDING-LIGHT-SW	1			C: 09, 11, 60, 68, 91	P: 72
R-SEPARATION-SW	1			C: 09, 44, 58, 91	
REFUEL-AUX1-SW	1			C: 09, 44, 91	
REFUEL-AUX2-SW	1			C: 09, 44, 91	
REFUEL-AUX3-SW	1			C: 09, 44, 91	
REFUEL-AUX4-SW	1			C: 09, 44, 91	
REFUEL-EXRG1-SW	1			C: 09, 44, 91	
REFUEL-EXRG2-SW	1			C: 09, 44, 91	
REFUEL-EXRG3-SW	1			C: 09, 44, 91	
REFUEL-EXRG4-SW	1			C: 09, 44, 91	
TOTAL-FUEL-QTY	4	A08/13F		C: 09, 91	

AIR-CONDITIONING-SW	2	A01/14	C: 19, 25, 57, 92
APU-GEN-SELECT-SW	2		C: 03, 12, 19, 21, 56, 92 S: 03, 04
APU/EXT-POWER-SW	2		C: 03, 12, 19, 21, 56, 92 S: 04 P: 46
BUS-TIE1-OPEN-LT	1		C: 92
BUS-TIE2-OPEN-LT	1		C: 92
BUS-TIE3-OPEN-LT	1		C: 92
BUS-TIE4-OPEN-LT	1		C: 92
CSD1-DISCONNECT-SW	1		C: 12, 92 S: 03, 09
CSD1-FAIL-LT	1		C: 92
CSD2-DISCONNECT-SW	1		C: 12, 92 S: 03, 10
CSD2-FAIL-LT	1		C: 92
CSD3-DISCONNECT-SW	1		C: 12, 92 S: 03, 11
CSD3-FAIL-LT	1		C: 92
CSD4-DISCONNECT-SW	1		C: 12, 92 S: 03, 12
CSD4-FAIL-LT	1		C: 92
ENG1-A/I-SW	2	A04/20	C: 10, 25, 44, 57, 92
ENG1-AUG-AIR-SW	1		C: 44, 57, 92
ENG1-BLEED-AIR-SW	1	A04/16	C: 57, 92 S: 54
ENG1-N2-RPM	3	A04/09C	C: 92, 93 S: 04, 17, 18, 76
ENG1-START-VALVE-OPEN-LT	1		C: 92, 93
ENG2-A/I-SW	1	A04/21	C: 10, 25, 44, 57, 92
ENG2-AUG-AIR-SW	1		C: 44, 57, 92
ENG2-BLEED-AIR-SW	1	A04/17	C: 57, 92 S: 54
ENG2-N2-RPM	3	A04/02C	C: 92, 93 S: 04, 23, 24, 77
ENG2-START-VALVE-OPEN-LT	1		C: 92, 93
ENG3-A/I-SW	1	A04/22	C: 10, 25, 44, 57, 92
ENG3-AUG-AIR-SW	1		C: 44, 57, 92
ENG3-BLEED-AIR-SW	1	A04/18	C: 57, 92 S: 73
ENG3-F-N2-RPM	3	A04/06C	C: 92 S: 04, 33
ENG3-START-VALVE-OPEN-LT	1		C: 92, 93
ENG4-A/I-SW	1	A04/23	C: 10, 25, 44, 57, 92
ENG4-AUG-AIR-SW	1		C: 44, 57, 92
ENG4-BLEED-AIR-SW	1	A04/19	C: 57, 92 S: 73
ENG4-F-N2-RPM	3	A04/05C	C: 92 S: 04, 39
ENG4-START-VALVE-OPEN-LT	1		C: 92, 93
GEN-VOLTS-&-FREQ-SW	2	M01/03	C: 03, 21, 56, 92 S: 03, 04
GEN1-OUT-LT	1		C: 92
GEN2-OUT-LT	1		C: 92 P: 49
GEN3-OUT-LT	1		C: 92
GEN4-OUT-LT	1		C: 92
ICE-ARMED-SW	1		C: 10, 25, 92
LAPU-BLEED-AIR-SW	1		C: 03, 19, 21, 56, 57, 92 S: 54, 73
MON-BUS2-OVRD-SW	1		C: 03, 12, 21, 56, 92
MON-BUS3-OVRD-SW	1		C: 03, 12, 21, 56, 92
PTU-1/2-SW	1		C: 10, 11, 25, 44, 59, 63, 92 S: 77
PTU-2/3-SW	1		C: 44, 59, 63, 92 S: 77, 78
RAPU-BLEED-AIR-SW	1		C: 03, 19, 21 56, 57, 92
SYS1-ATM-PUMP-SW	1		C: 19, 21, 44, 59, 63, 92 S: 76
SYS1-BOOST-PRES-LOW-LT	1		C: 10, 92

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PARAMETER 50 P.50

GEN3-LOADMETER	4		P: 50
GEN3-SW	2		C: 03, 12 S: 03, 04 P: 50

PARAMETER 51 P.51

GEN4-LOADMETER	4		P: 51
GEN4-SW	2		C: 03, 12 S: 03, 04 P: 51

PARAMETER 52 P.52

GROUND-SPEED	3	INS?	S: 63, 64, 65, 66, 68 P: 52
ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84

PARAMETER 53

P.53

L-LANDING-LIGHT-SW	1		C: 09, 11, 60, 68, 91 P: 53

PARAMETER 54

P.54

ENG1-BLEED-AIR-SW	1	A04/16	C: 57, 92 S: 54
ENG2-BLEED-AIR-SW	1	A04/17	C: 57, 92 S: 54
L-DUCT-OVERHEAT-LT	1		S: 54
L-MANIFOLD-PRESSURE	3	A07/17,25	S: 54
LAPU-BLEED-AIR-SW	1		C: 03, 19, 21, 56, 57, 92 S: 54, 73

PARAMETER 55

P.55

LANDING-GEAR-LEVER	1	A01/03	C: 10, 11, 12, 13, 14, 94 S: 55 P: 59, 60, 61, 62, 67
ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84

PARAMETER 56

P.56

LAPU-CONT-SW	2		C: 03, 19, 21, 25, 56 S: 56
LAPU-EGT-IND	3	A03/02	S: 56
LAPU-ON-SPEED-LT	1		C: 03, 21 S: 03, 04, 56
ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84

PARAMETER 57

P.57

AIRSPEED	3		C: 14, 64 S: 05, 47, 57, 69, 75
ALTITUDE	4	A06/30F	DEHAL S: 01, 02, 05, 57
MACH	4	A05/30F	S: 05, 57
NLG-IND	2		S: 05, 57 P: 67
VERTICAL-SPEED	3		S: 05, 47, 57, 71 P: 83

PARAMETER 58 P.58

MAG-HEADING	3	EHAL S: 58
ON-GROUND	1 A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84
THROTTLE1	3 A01/30C	C: 22, 64, 68, 93, 94 S: 14, 58, 71
THROTTLE2	3 A01/29C	D C: 22, 64, 68, 93, 94 S: 26, 58, 71

PARAMETER 59 P.59

LANDING-GEAR-LEVER	1 A01/03	C: 10, 11, 12, 13, 14, 94 S: 55 P: 59, 60, 61, 62, 67
MLG-EMER-EXT-L-A	1	P: 59
MLG-IND-L-A	2	S: 05 P: 59

PARAMETER 60 P.60

LANDING-GEAR-LEVER	1 A01/03	C: 10, 11, 12, 13, 14, 94 S: 55 P: 59, 60, 61, 62, 67
MLG-EMER-EXT-L-F	1	P: 60
MLG-IND-L-F	2	P: 60

PARAMETER 61 P.61

LANDING-GEAR-LEVER	1 A01/03	C: 10, 11, 12, 13, 14, 94 S: 55 P: 59, 60, 61, 62, 67
MLG-EMER-EXT-R-A	1	P: 61
MLG-IND-R-A	2	P: 61

PARAMETER 62 P.62

LANDING-GEAR-LEVER	1 A01/03	C: 10, 11, 12, 13, 14, 94 S: 55 P: 59, 60, 61, 62, 67
MLG-EMER-EXT-R-F	1	P: 62
MLG-IND-R-F	2	P: 62

PARAMETER 63 P.63

GROUND-SPEED	3 INS?	S: 63, 64, 65, 66, 68 P: 52
MLG-POS-IND-L-A	4	C: 68 S: 63
ON-GROUND	1 A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84

PARAMETER 64 P.64

GROUND-SPEED	3 INS?	S: 63, 64, 65, 66, 68 P: 52
MLG-POS-IND-L-F	4	C: 68 S: 64
ON-GROUND	1 A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84

PARAMETER 65 P.65

GROUND-SPEED	3 INS?	S: 63, 64, 65, 66, 68 P: 52
MLG-POS-IND-R-A	4	C: 68 S: 65
ON-GROUND	1 A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84

PARAMETER 66 P.66

GROUND-SPEED	3 INS?	S: 63, 64, 65, 66, 68 P: 52
MLG-POS-IND-R-F	4	C: 68 S: 66
ON-GROUND	1 A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84

PARAMETER 67 P.67

LANDING-GEAR-LEVER	1 A01/03	C: 10, 11, 12, 13, 14, 94 S: 55 P: 59, 60, 61, 62, 67
NLG-EMER-EXT-SW	1	P: 67
NLG-IND	2	S: 05, 57 P: 67

PARAMETER 68 P.68

GROUND-SPEED	3	INS?	S: 63, 64, 65, 66, 68 P: 52
NLG-POS-XWIND-IND	4		C: 68 S: 68
ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84

PARAMETER 69 P.69

AIRSPEED	3		C: 14, 64 S: 05, 47, 57, 69, 75
NLG-STEERING-IND	4		S: 69
ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84

PARAMETER 70 P.70

NOSE-LANDING-LIGHT-SW	1		C: 11, 60, 68 P: 70

PARAMETER 71 P.71

ALTITUDE-AGL	3		C: 09, 64, 91, 94 S: 05, 07, 08, 47, 71, 75
PITCH	3	FDC	S: 71
THROTTLE1	3	A01/30C	C: 22, 64, 68, 93, 94 S: 14, 58, 71
THROTTLE2	3	A01/29C	D C: 22, 64, 68, 93, 94 S: 26, 58, 71
VERTICAL-SPEED	3		S: 05, 47, 57, 71 P: 83

PARAMETER 72 P.72

R-LANDING-LIGHT-SW	1		C: 09, 11, 60, 68, 91 P: 72

PARAMETER 73 P.73

ENG3-BLEED-AIR-SW	1	A04/18	C: 57, 92 S: 73
ENG4-BLEED-AIR-SW	1	A04/19	C: 57, 92 S: 73
LAPU-BLEED-AIR-SW	1		C: 03, 19, 21, 56, 57, 92 S: 54, 73
R-DUCT-OVERHEAT-LT	1		S: 73
R-MANIFOLD-PRESSURE	3	A07/10,14	S: 73

PARAMETER 74 P.74

ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84
RAPU-CONT-SW	2		C: 03, 19, 21, 25, 56 S: 74
RAPU-EGT-IND	3	A03/06	S: 74
RAPU-ON-SPEED-LT	1		C: 03, 21 S: 03, 04, 74

PARAMETER 75 P.75

AIRSPEED	3		C: 14, 64 S: 05, 47, 57, 69, 75
ALTITUDE-AGL	3		C: 09, 64, 91, 94 S: 05, 07, 08, 47, 71, 75
ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84
ROLL	3	SAME	S: 75 P: 82 ; AS BANK

PARAMETER 76 P.76

ENG1-N2-RPM	3	A04/09C	C: 92, 93 S: 04, 17, 18, 76
SYS1-ATM-PUMP-SW	1		C: 19, 21, 44, 59, 63, 92 S: 76
SYS1-ATM-START-SW	1		C: 21, 44, 59 S: 76
SYS1-BOT-SW	1		C: 19, 21, 25, 44, 92 S: 76
SYS1-HYD-PRESSURE	3		C: 21, 25, 92 S: 76, 77
SYS1-TOP-SW	1		C: 19, 21, 25, 44 S: 76

PARAMETER 77 P.77

ENG2-N2-RPM	3	A04/02C	C:	92,	93	S:	04,	23,	24,	77							
PTU-1/2-SW	1		C:	10,	11,	25,	44,	59,	63,	92	S:	77					
PTU-2/3-SW	1		C:	44,	59,	63,	92	S:	77,	78							
SYS1-HYD-PRESSURE	3		C:	21,	25,	92	S:	76,	77								
SYS2-BOT-SW	1		C:	19,	21,	44,	92	S:	77								
SYS2-HYD-PRESSURE	3		C:	92	S:	77,	78										
SYS2-TOP-SW	1		C:	19,	21,	44	S:	77									
SYS3-HYD-PRESSURE	3		C:	92	S:	77,	78										

PARAMETER 78 P.78

ENG3-P-N2-RPM	3	A04/06C	C:	93	S:	35,	78										
PTU-2/3-SW	1		C:	44,	59,	63,	92	S:	77,	78							
PTU-3/4-SW	1		C:	10,	11,	25,	44,	59,	63	S:	78						
SYS2-HYD-PRESSURE	3		C:	92	S:	77,	78										
SYS3-BOT-SW	1		C:	19,	21,	44,	92	S:	78								
SYS3-HYD-PRESSURE	3		C:	92	S:	77,	78										
SYS3-TOP-SW	1		C:	19,	21,	44	S:	78									
SYS4-HYD-PRESSURE	3		C:	21,	25,	92	S:	78,	79								

PARAMETER 79 P.79

ENG4-P-N2-RPM	3	A04/05C	C:	93	S:	43,	79										
SYS4-ATM-PUMP-SW	1		C:	19,	21,	44,	59,	63,	92	S:	79						
SYS4-ATM-START-SW	1		C:	21,	44,	59	S:	79									
SYS4-BOT-SW	1		C:	19,	21,	25,	44,	92	S:	79							
SYS4-HYD-PRESSURE	3		C:	21,	25,	92	S:	78,	79								
SYS4-TOP-SW	1		C:	19,	21,	25,	44	S:	79								

PARAMETER 80 P.80

GEN1-BUS-TIE-SW	2		C:	03,	12	P:	80										
T/R1-DC-LOAD	4		P:	80													

PARAMETER 81 P.81

GEN4-BUS-TIE-SW	2		P:	81													
T/R2-DC-LOAD	4		P:	81													

PARAMETER 82 P.82

FLAP-POS-IND	3	A18/29CF	C: 14, 22, 24, 26, 60, 68, 94 S: 05, 14, 26, 30, 38, 47 P: 82
ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84
ROLL	3	SAME	S: 75 P: 82 ; AS BANK
VERT-ACCELEROMETER	4	A05/21F	P: 82

PARAMETER 83 P.83

ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84
VERTICAL-SPEED	3		S: 05, 47, 57, 71 P: 83

PARAMETER 84 P.84

ON-GROUND	1	A15/27	DL C: 03, 04, 09, 64, 91, 94 S: 05, 06, 14, 26, 30, 38, 47, 55, 56, 58, 63, 64, 65, 66, 68, 69, 74, 75 P: 52, 82, 83, 84
YAW	4		P: 84

APPENDIX H

SIGNALS REQUIRED FOR NAVIGATIONAL PROFILES

SOURCE OF VARIABLES REQUIRED FOR NAVIGATIONAL PROFILE RELATED MONITORING

NAVIGATIONAL PROFILES

IMPORTANCE*	VARIABLE	TYPE	SOURCE
1	THROTTLE2	3	MADARS A01/29C
1	THROTTLE3	3	MADARS A01/26C
2	ADF1-FREQUENCY	3	
2	ADF1-FUNC-SW	2	
2	ADF2-FREQUENCY	3	
2	ADF2-FUNC-SW	2	
2	MAG-HEADING	3	
2	TACAN1-ANT-SW	2	
2	TACAN1-CHANNEL	3	
2	TACAN1-FUNC-SW	2	
2	TACAN1-MODE-SW	1	
2	VOR1-FREQUENCY	4	
2	VOR1-SW	1	
2	VOR2-FREQUENCY	4	
2	VOR2-SW	1	
3	BANK	3	INS
3	C-NAV-SELECT	2	FDC2
3	C-RATE-OF-TURN	4	SAME AS RATE-OF-TURN
3	INS1/3-ROLL	3	SAME AS BANK
3	INS2/3-ROLL	3	SAME AS BANK
3	P-NAV-SELECT	2	FDC1
3	P-RATE-OF-TURN	4	SAME AS RATE-OF-TURN
3	RATE-OF-TURN	4	
4	ON-GROUND	1	MADARS A15/27
5	C-ROLL-HUB-FORCE	3	
5	P-ROLL-HUB-FORCE	3	
5	PITCH-C-HUB-FORCE	3	
5	PITCH-P-HUB-FORCE	3	
6	C-COURSE-SET	3	
6	COURSE-SET	3	COMPUTED BASED ON WHO IS FLYING
6	P-COURSE-SET	3	
6	TACAN-DME	4	FDC1
6	TACAN1-DME	4	SAME AS TACAN-DME
6	TACAN2-DME	4	???
7	ALTITUDE	4	MADARS A06/30F
7	C-ALTITUDE	4	SAME AS ALTITUDE

7	C-CDI-WARNING	1	FDC2
7	C-G/S-DEVIATION-WARN	1	FDC2
7	CDI-WARNING	1	COMPUTED BASED ON WHO IS FLYING
7	GSI-WARNING	1	COMPUTED BASED ON WHO IS FLYING
7	P-ALTITUDE	4	SAME AS ALTITUDE
7	P-CDI-WARNING	1	FDC1
7	P-G/S-DEVIATION-WARN	1	FDC1
9	C-CDI	4	FDC2
9	C-G/S-DEVIATION-IND	4	FDC2
9	CDI	4	COMPUTED BASED ON WHO IS FLYING
9	GSI	4	COMPUTED BASED ON WHO IS FLYING
9	LATITUDE	5	INS
9	LONGITUDE	5	INS
9	P-CDI	4	FDC1
9	P-G/S-DEVIATION-IND	4	FDC2

MONITORABLE PARAMETERS

IMPORTANCE*	VARIABLE	TYPE	SOURCE
2	ANGLE-OF-ATTACK	3	
3	L-LANDING-LIGHT-SW	1	
3	NOSE-LANDING-LIGHT-SW	1	
3	R-LANDING-LIGHT-SW	1	
3	VERTICAL-SPEED	3	
4	GROUND-SPEED	3	
4	ON-GROUND	1	MADARS A15/27
5	NLG-STEERING-IND	4	
6	PITCH	3	FDC
6	ROLL	3	SAME AS BANK
6	YAW	4	
7	ALTITUDE	4	MADARS A06/30F
8	AIRSPEED	3	
8	ALTITUDE-AGL	3	
8	FLAP-HANDLE	3	
8	FLAP-POS-IND	3	MADARS A18/29CF
8	LANDING-GEAR-LEVER	1	MADARS A01/03
8	NLG-IND	2	

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* IMPORTANCE RANGES 0..9, LEAST..MOST

APPENDIX I

SYSTEM DEVELOPMENT COSTS

The following cost estimates are provided based on the design of an Airborne Performance Measurement System as presented in Part IV of the final report. The cost estimates are a function of 1983 rates and will vary with the implementation schedule.

Labor	$295,000
Material	106,000
Travel	26,000
Computer Time	8,200
Documentation	100
Total Development Cost	$435,300

The labor estimate includes engineering time to design, manufacture and implement the system. This includes both hardware and software engineering, plus the time required to produce system documentation.

The material estimate includes all hardware components, both off-the-shelf items as well as newly designed equipment. Also included are costs for a microcomputer development system and material items to support the development effort.

The travel costs include trips for existing system research and installation and checkout. The computer time cost is for software development at the contractor's facility.